POWER

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"Come on! Don't You Get Enough Engines All Week?"

Consumers New Ice Plant at South Chicago

Synchronous-Motor-Driven Ammonia Compressors Show the Remarkable Economy Indicated by 25.8 Kilowatt-Hours per Ton of Ice—A Suction Pressure of 28 or 29 Pounds Is Average Practice

By GILBERT SELLERS
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IN THE South Chicago ice plant of the Consumers Company may be seen an example of the culmination of the rapid change in ice manufacture that has characterized the last decade. In this plant synchronous motors are directly connected to the shafts of the ice machines. These motors are comparatively low in speed, and the ice machines, judged by usual standards, are high in speed. It was a question of give and take, and the engineers, in designing these units, arbitrated the difficulty at 154 r.p.m.

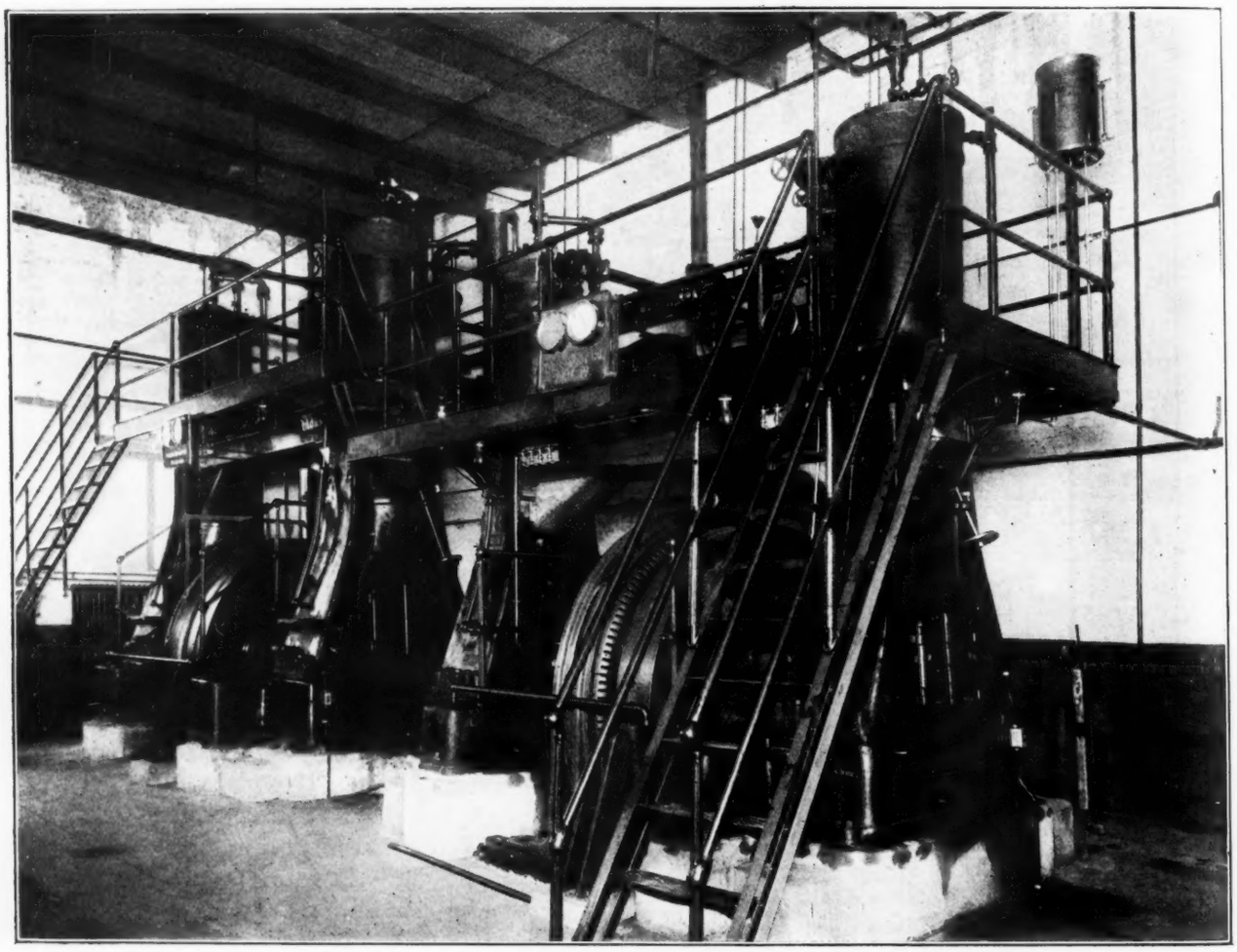


FIG. 1. SYNCHRONOUS-MOTOR-DRIVEN COMPRESSORS IN CONSUMERS ICE COMPANY'S PLANT

At the present time there are two main compressor units, one having a nominal rating of 90 tons and the other, 47 tons. Each unit is made up of two York single-acting vertical compressors placed on either side of and direct-connected to a General Electric synchronous motor. The cylinder dimensions of the larger unit are 16 x 20 in. and of the small machine, 12½ x 16 in. The motor ratings are 250 hp. and 125 hp. respectively. Both machines are served by an atmospheric ammonia condenser having 22 stands of 2-in. pipe, 15 deep and 18 ft. long. The practice will be to operate the smaller machine during the winter months, the larger unit during moderate weather and the two machines throughout the summer. At the present time the 90-ton machine is in operation and developing 142 tons.

To secure a low condensing pressure the designers of the plant have installed the condenser in such a way as to take the maximum advantage of the heat relations of the cooling water and the ammonia vapor. The hot ammonia vapor enters the condenser at the third pipe from the bottom and passes down through the lower three pipes, where it meets a bleeder line which

drains the condensed ammonia to the liquid receiver. From the bottom pipe the vapor which has not been condensed passes upward to the top pipe of the condenser and flows through the coils down to the fourth pipe from the bottom. Here again is a liquid header leading to the receiver. This arrangement is outlined in Fig. 2.

As the water passes over these coils from the top, it is easily seen that a little reheating of the ammonia liquid that is condensed in the upper coils will take place since, as it flows downward, it runs into a warmer cooling agency. If this plan were followed to the finish of the process, the liquid ammonia would leave the condenser surrounded by the hottest water. This arrangement would be detrimental, especially in weather not favorable to evaporation. However, in the condenser that the company has installed, superheat of the ammonia vapor is taken up as the final work of the cooling water and it has been found that no objectionable liquid heating occurs.

Pump-Out Machine Installed

In addition to the two main units a pump-out machine of six-ton rated capacity is installed. It is so connected that it may be used on any isolated section of the entire system. Care has been taken in installing the large units to run the returning gas lines so as to prevent either machine from robbing gas from the other. The idea was to install the ice machines in such a way that, when running together, any liquid entering the returning gas lines is equally divided between the machines. Owing to the manner of isolating the sweet water and storage coils, it is easy to hold a back pressure of 30 lb. on the pump-out machine. With this high back pressure the old rating of six tons is obsolete and the small machine has become a 9- to 10-ton unit.

POWER REQUIRED AT VARIOUS SUCTION PRESSURES

Suction Pressure, Lb.	Temp. of Coils, Deg. F.	Brine Temp., Deg. F.	Brake Hp. Per Ton	Kw.-Hr. Per Ton
15.67	0.0	10.0	1.866	33.4
17.50	2.5	12.5	1.763	31.6
20.00	5.7	15.7	1.646	29.5
22.50	8.7	18.7	1.531	27.4
25.00	11.5	21.5	1.443	25.8

During the winter months, when only the smaller ice machine is operated in connection with the auxiliary machinery, it has been found more economical to run this pump-out machine, as it requires no additional auxiliary power. The auxiliary machinery is designed to take care of an ice plant of 125 tons capacity. Therefore, when harvesting only 78 tons, it is poor economy to allow the 10-ton unit to remain idle.

In the water-cooling tanks there is 1,325 ft. of 1¼-in. pipe and 7,000 ft. of 2-in. pipe in the storage rooms. Add to this the 37,500 ft. of evaporating coils in the brine tanks, and it will be seen that there is sufficient evaporating surface to hold a constant, high back pressure on the machines under almost any condition arising.

In the South Chicago plant it has been the practice to operate on a suction pressure of 28 to 29 lb. while holding the brine at a temperature of 19 deg. and harvesting 88 tons of ice. The condenser pressure will vary with the season. In this plant it is the plan to maintain it between 65 and 90 lb. during the winter and probably 165 and 180 lb. during the summer. In the old-time plant it has been the author's experience that when the back pressure exceeded 17 lb., a return of liquid to the compressor could be expected. The gain in efficiency with an increase in suction pressure is made evident in the accompanying table. The factor of danger in operating machines designed for normal pressure at the higher suction pressures does not amount to anything. From the table it may be seen that higher efficiency is secured by operating at the higher suction pressures. To make this possible it was necessary to install more evaporating surface to enable the ammonia to absorb enough heat to maintain this pressure.

It must be borne in mind that a foot of coil in the fore-cooling tanks is worth as much as four feet in the brine tanks. In the latter heat must travel from the center of the ice cans to the refrigerant through ice, can walls and brine, while in the fore-cooler heat enters the ammonia directly from the water. Evidence of this contention may be had by observing the ice as it forms in the cans. It will be noticed that one-half of the ice is formed in one-fourth of the freezing time. The slowing up of the freezing process is caused, of course, by the ice itself being a non-conductor. This disadvantage encountered in the brine tank is not found in the water cooler. Here every inch of the ammonia coils is doing its maximum work as a conductor. Directly on its outer wall is the water above the freezing point, sometimes many degrees, and within is the refrigerant absorbing the heat as it passes on to the compressor.

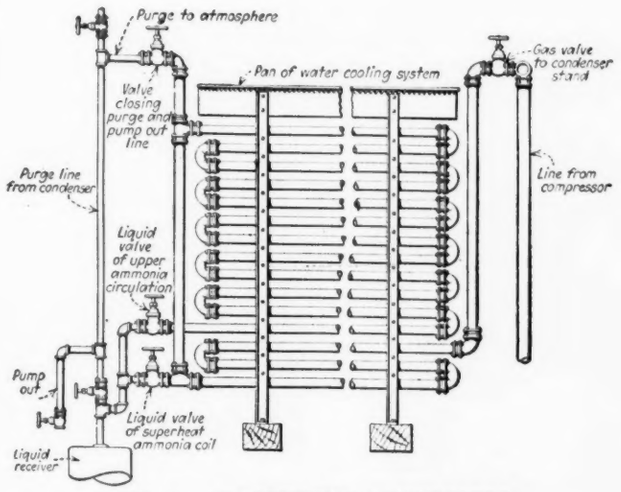

Purge to atmosphere
Gas valve to condenser stand
Pan of water cooling system
Valve closing purge and pump out line
Purge line from condenser
Line from compressor
Liquid valve of upper ammonia circulation
Pump out
Liquid valve of superheat ammonia coil
Liquid receiver

FIG. 2. ATMOSPHERIC CONDENSERS

By putting the 1,325 ft. of 1¼-in. pipe in the fore-cooling tank, the water is chilled to 34 deg. F. This makes it possible to use the brine almost solely for the congealing of the can ice.

To secure a uniform condition in the returning ammonia vapor, precaution has been taken to install the accumulators so that the liquid ammonia will not enter the lines and eventually reach the compressor. The header on the evaporating coils in the brine tank is connected to the accumulator on a level with the top of the brine. The accumulator is large and stands 7 ft. above the header in the brine tank, while below it extends to the bottom of the brine tank. The returning gas main issues from the top of the accumulator. This arrangement, which appears in Fig. 3, enables the engineer to give the evaporating coils a copious supply of ammonia without fearing that liquid will enter the suction line. The returns from the ammonia coils in the ice-storage room and the fore-cooling tanks enter

the accumulator at a point a few inches above the brine level.

In the freezing tanks there are 1,280 cans for 400-lb. blocks. With a 125-ton plant this gives more than 10 cans per ton. This presents can surface enough, with what surface there is in the cooling tanks, to permit a back pressure nearing 29 pounds.

As a future aid to economical operation of the plant the synchronous-motor drive offers advantages. It has long been the desire of engineers to get away from belt-driven machinery. The old belt-slippage problem has been attacked at every angle, yet after all trials have been made, there are still the slippage loss, costly belts to keep up, floor space taken up, and undue friction due to the belt tension. Engineers have turned their attention at last to the slow-speed motor, with the result that the synchronous motor is now pulling the load with a speed that is absolutely constant. In this manner the foregoing defects have been overcome, and at the same time a neater engine room and a more dependable drive have been secured.

The constant speed of the synchronous motor is an important factor not commonly observed. Constant rate of flow of the ammonia gas to the compressor is desirable, and the constant speed of the compressor is quite as important. With the direct-connected ice machine the engineer can be in any part of the plant and know that the compressor is taking in the gas at the same rate that he observed when in the engine room.

For the 1,280 ice cans previously mentioned, there are two brine tanks. Each tank has but two expansion valves, and these two valves are connected to a single header in the bottom of the brine tank. Also, for the return gas there is but one header. On account of each expansion valve feeding so many feet of evaporating coils, it must be left so wide open that there is no chance for oil or other impurities to gather at the valve and obstruct, temporarily, the flow of the liquid. In the old-fashioned tank where there was an expansion valve for each coil or even for each four coils, the expansion valves had to be left so nearly closed that the engineer was forced to go to them frequently and "shake them up." This constant attention took up so much of his time, it may be said with truth that he hand-fed the liquid ammonia. Such a system could not be operated economically.

As a result of the old-time system of many expansion valves and variable speed of the compressor, the engineer often had to run back and forth like a shuttle from his engine room to the tank room. He went to his tank to "shake up" the valves and returned to the engine room to find the compressor lagging. One minute he had a shot of saturated gas or liquid, and in another few minutes he was pumping toward a vacuum with the rods burning the packing.

In these older plants very few headers, receivers or accumulators were built in a manner that would enable the engineer to reduce from the king valve and secure a uniform flow of liquid in all the coils. It is readily possible in the South Chicago plant with its single header for liquid in each tank fed by only two valves and connected to accumulators in the return line so that no spill-over can take place. The system is simple in design, easy to operate and efficient.

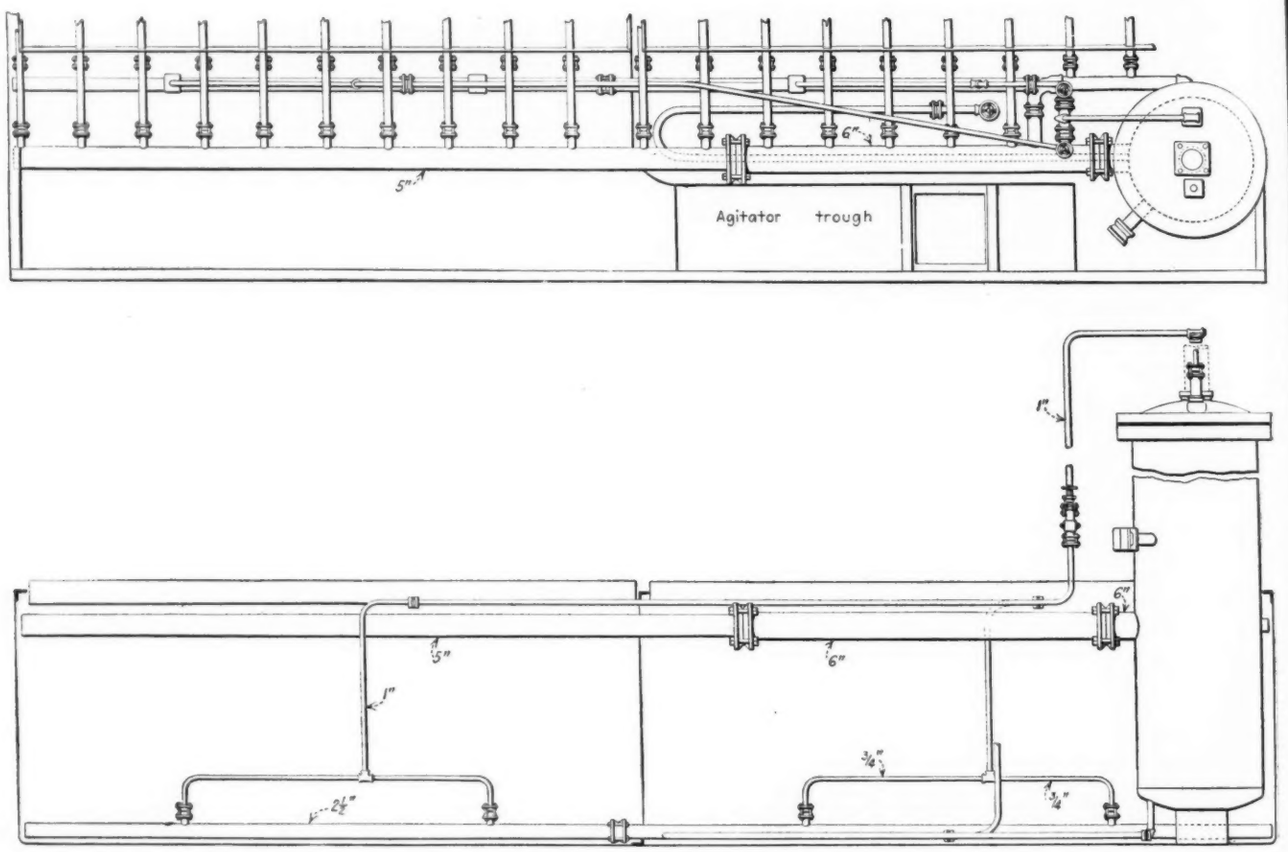


FIG. 3. ACCUMULATOR AND EXPANSION SYSTEM

Wilkins Pressure Regulator

A particular feature of interest is found in the pressure regulator used with the Wilkins system of pressure regulation, in the shape of a flexible diaphragm. This diaphragm is made of german silver and consists of a central disc, Fig. 2, and an outer ring, the two being

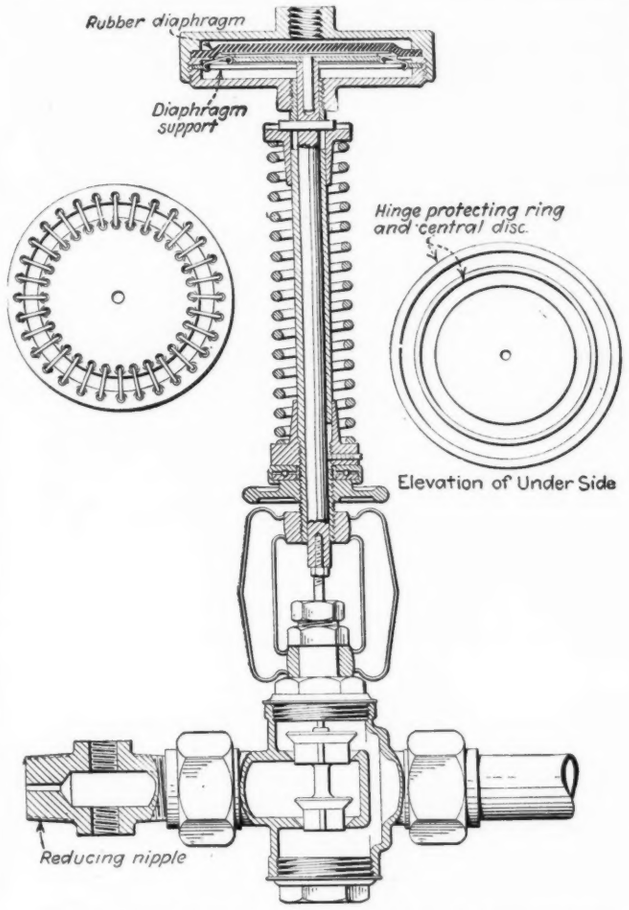


FIG. 1. APPLICATION OF DIAPHRAGM TO REGULATOR

connected by means of wire hinge loops. The hinges are protected by a ring and the center piece. The application to the rubber diaphragm is shown in Fig. 1, which also shows the reducing nipple that is used in the system. This regulator, manufactured by the Wilkins Automatic Regulator Co., Erie, Pa., when used for draft and stoker control is so arranged that the master valve *D*, Fig. 3, is connected to the steam main by the pipe *E* through a reducing nipple *F*, provided with a restricted opening, as shown by the enlarged view. The valve *D* is operated by changes in pressure in the pipe *E* which, through the pipe *A*, communicates with the diaphragm of the valve; when the pressure in the pipe decreases, the valve *D* will open.

To the bottom of the reducing nipple *F* a pipe *H* is connected and communicates with the controlling mechanism of the valve *I*, which controls the flow of steam from the steam main to the stoker and to the fan engines. These valves are provided with small bypasses (see enlarged section) through which sufficient steam will flow to keep the engine just turning over. The pipe is also connected to the damper control *K*.

When the pressure in the steam main drops below a predetermined point, the master valve *D* opens and the

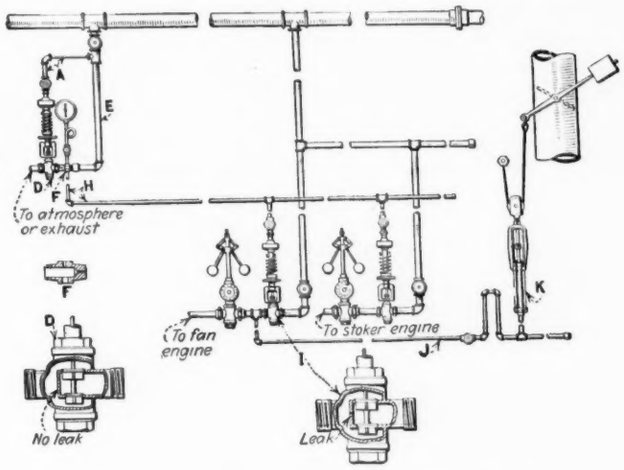


FIG. 3. PIPING OF PRESSURE REGULATORS

pressure in the reducing nipple *F* and in the pipe *H* exhausts to the atmosphere or to a heater, thus relieving the pressure above the diaphragm of the valves *I*, when the springs will gradually open the valves and steam will be admitted to the stoker and fan engines, which will speed up until controlled by the governors. The operation is reversed with a rising pressure in the steam main, when the master valve will close. The system provides for a gradual acceleration of the fuel and draft supply upon a falling pressure and a gradual decrease when the pressure regains its maximum.

The maximum steam pressure can be determined by adjusting a spring of the master-valve controlling mechanism, and the maximum and minimum damper opening can be adjusted by means of moveable setscrew collars mounted on the damper piston rod. As the pipes connecting with the diaphragms are filled with water of condensation the diaphragms are protected from live steam temperature.

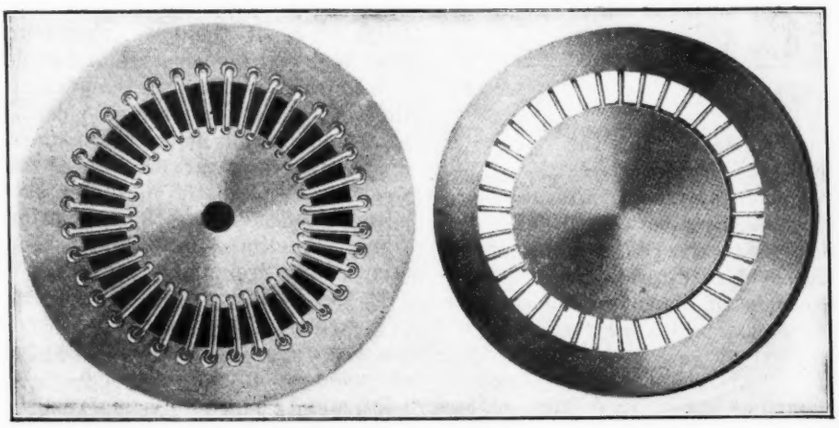


FIG. 2. TOP AND BOTTOM OF FLEXIBLE DIAPHRAGM

New Unaflow Engine Design

Equipped with High-Lift Poppet Valves of Small Diameter, Which Are Operated from a Valve Shaft, Geared To Run at Twice the Speed of the Main Engine Shaft

RECENT improvements in the unaflow engine have been made by Prof. J. Stumpf with a view to minimize the losses due to cylinder condensation, excessive clearance, wiredrawing, friction, leakage, radiation, conduction and incomplete expansion.

Fig. 1 shows a sectional elevation of the engine cylinder, in which the small diameter of the valves may be noted. The improved arrangement of valve gear permits a much greater valve lift to be obtained than is possible in present designs in which the main engine shaft and the valve shaft operate at the same speed. Fig. 2 shows this graphically; with a 10 per cent cutoff the angle of advance of the driving eccentric is increased from α to 2α resulting in an increased valve lift of from a' to a; the latter being four times as great as the former. A double-seated valve 200 mm. (7.87 in.) in diameter may therefore be replaced by a single-seated valve which is only 100 mm. (3.93 in.) in diameter to admit the same amount of steam for any given cutoff.

Fig. 3 shows a proposed arrangement of the valve gear. An adjustable eccentric *A* operated from the valve shaft *B* is connected to the yoke *C*, which is mounted eccentrically upon the auxiliary valve shaft *D*. The latter rotates at the same speed as the mainshaft. The other end of the yoke is connected by the rod *E* to a bell crank *F* fitted with a roller that bears against a cam *G* to lift the valve off its seat.

The relation between the eccentric and the eccentrically pivoted yoke is such that the effect of their respective travel is added to increase the valve lift and is

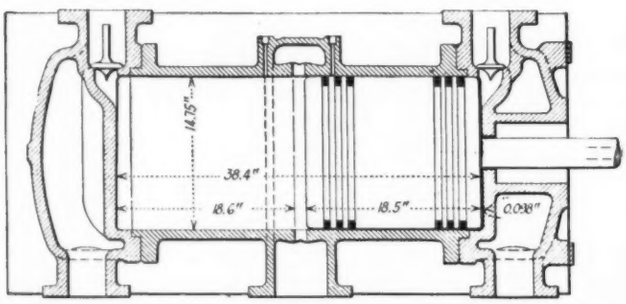


FIG. 1. SECTIONAL ELEVATION OF UNAFLOW CYLINDER

then subtracted and neutralized during the remainder of the stroke, when the valve remains at rest.

The use of small-diameter valves permits clearance space to be reduced to somewhere between $\frac{3}{4}$ and 1 per cent. Similarly, the surface exposed to the steam at admission may be reduced to within 3 to 5 per cent of the ideal, which would consist of the sum of the cylinder head areas.

Reducing Cylinder Condensation

The improvement described serves to further reduce the relatively small cylinder condensation resulting from the decreased temperature differences in the various zones of the uniflow cylinder during each piston stroke. A test on a unaflow engine operating condensing with a very high vacuum and in which only the cylinder heads were steam-jacketed, conducted by Professor Nagel at Dresden, showed a temperature drop of less than 180 deg. F. at the head end with the engine exhausting into the condenser. Fig. 4 shows the rise and

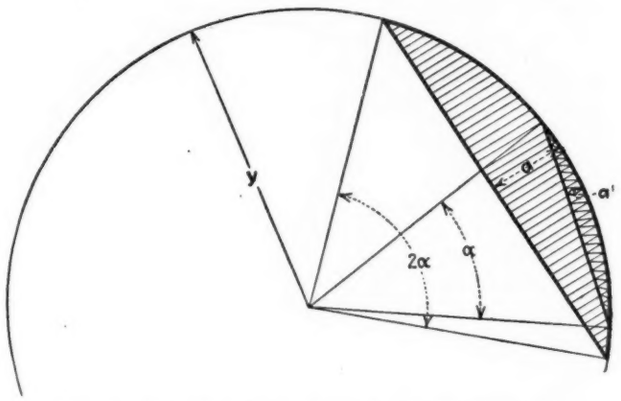


FIG. 2. VALVE-LIFT DIAGRAM WITH OLD AND NEW DRIVE

fall in temperature within the cylinder during a complete revolution of the engine shaft.

The low temperature of the exhaust causes considerable condensation to take place in the steam entrapped behind the piston upon closure of the exhaust ports on the return stroke. The resulting wet steam with a moisture content estimated at about 20 per cent, because of its low temperature and high conductivity, rapidly absorbs heat from the jacketed cylinder head. Practically none of this heat is wasted, but is stored in the steam during the compression period. With a clearance of 3.3 per cent the steam is compressed to from 2.5 to 3 atmospheres, or from 37 to 44 pounds.

Compression takes place along the adiabatic curve for saturated steam until the superheated stage is reached and is completed along the much steeper adiabatic curve of the latter, whereupon the remarkably high terminal temperature of 950 deg. F. is obtained.

Admission causes this temperature to drop to that of the entering steam, or to 505 deg. F. Expansion takes place adiabatically with the steam in a superheated condition until the saturated state is reached, when it again follows the adiabatic curve for saturated steam. The latter is raised above the normal by the heat absorbed from the cylinder head, which tends to neutralize the temperature drop upon the opening of the exhaust ports.

If the clearance space is reduced from 3.3 per cent to a volume of between $\frac{3}{4}$ to 1 per cent, as obtained in the new design, the temperature of the steam at the end of compression is increased to somewhere between 1,652 and 1,832 deg. F.

Professor Nagel's tests showed the somewhat astonishing fact that the compression temperature obtained with the engine operating on saturated steam

was actually 180 deg. F. higher than with superheated steam. This apparent paradox may be explained by the better conductivity of saturated steam, which enables it to absorb a greater quantity of heat.

This advantageous thermal condition, together with the small surface exposed by the new poppet-valve design, very nearly eliminates the loss due to cylinder condensation.

Reducing Clearance Losses

Clearance losses are governed by the clearance volume, the initial pressure, the back pressure, the mean effective pressure, the compression and the time allowed for compression. They become zero when the clearance is zero. The new engine design approaches this favorable condition with a total clearance volume of less than 1 per cent. The resulting clearance loss is therefore very small in spite of the single-stage expansion. The clearance space is proportioned to insure approximately identical ratios of expansion and compression.

Present types of unaflow engines with clearance volumes of from 3 to 5 per cent are therefore less efficient, owing to the greater pressure range and insufficient compression. For every 1 per cent in clearance volume, there will be a corresponding increase in steam consumption, amounting to 0.44 lb. with saturated steam and 0.33 lb. with superheated steam per horsepower-hour.

All work done by the steam is confined to a single cylinder; this eliminates the losses that occur in the

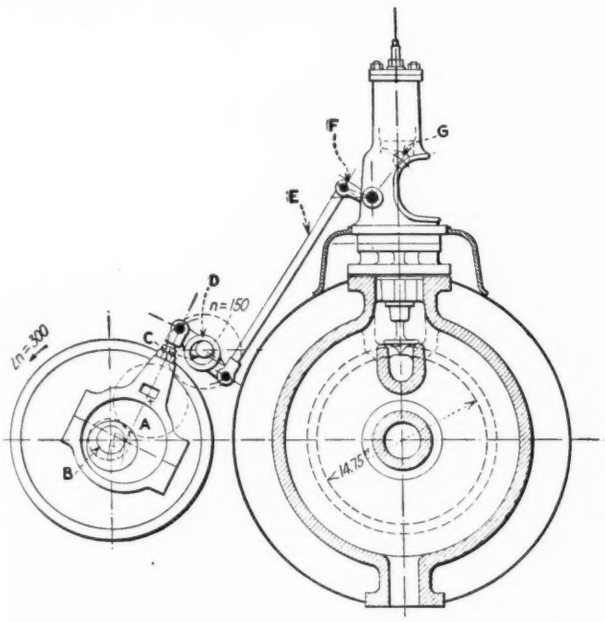


FIG. 3. VALVE DRIVE WITH AUXILIARY LAYSHAFT

pipe connections between the cylinders of compound or triple-expansion engines. The simple-cylinder construction with the central exhaust ports that are uncovered by the piston, permits the condenser to be moved close up to the cylinder. This results in the nearly perfect equalization of the vacuum within the cylinder and the condenser. Similarly, the throttling losses during admission may be minimized by the high lift of the valve. The wiredrawing is necessarily less in a single-seated valve than in the double-seated valve, which divides the steam into two streams.

By providing the high-lift poppet valve with a suitably designed diffuser, the already small wiredrawing losses may be further diminished.

Reducing Leakage Losses

The small diameter of the single-seated poppet valves makes them less subject to distortion under pressure and temperature changes. Hence their tightness is indefinitely preserved in contrast to double-seated poppet valves, which constantly give trouble due to leakage.

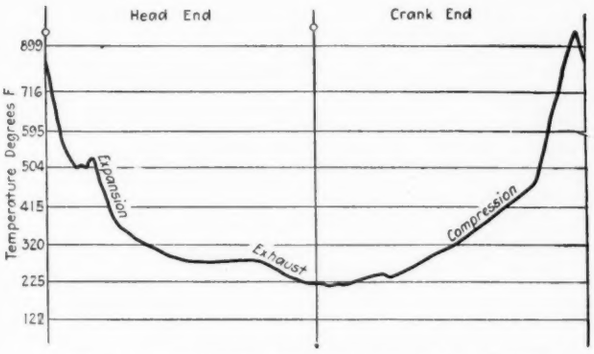


FIG. 4. CYLINDER TEMPERATURE WITH NEW VALVE ARRANGEMENT

The greater number of rings on the piston of the unaflow engine serve to minimize a leakage past them. Valve-stem and stuffing-box leakage may be easily prevented.

Conclusion

The new unaflow engine has shown a gain in economy of from 0.88 to 1.1 lb. per horsepower-hour, when compared to present types of uniflow engines.

The small clearance volume results in high compression, which assists the valves in opening. The higher valve-shaft speed permits a wider range in valve adjustment. An advantageous feature of the small-diameter poppet valve is the fact that this may be ground upon its seat at normal temperature, whereas the double-seated valve must be reground at operating temperature to insure tightness in service. Tests have established the fact that the new poppet valves remain tight under all operating conditions.

The new unaflow engine bears great similarity to the two-cycle internal-combustion engine, which is likewise equipped with small poppet inlet valves and slotted exhaust ports in the center of the cylinder. The uniform direction of steam flow is comparable to that within a steam turbine.

It may be safely concluded that the new unaflow engine represents a decided advance in the art and that it is very doubtful that the high economies obtained therewith in practice will ever be greatly exceeded.

An exceptionally high head (1,000 ft.) is the pressure against which two centrifugal pumps recently put into service by the municipal water works at Shenandoah, Pa., deliver two million gallons per day apiece. The installation is probably the largest high-head centrifugal pumping plant in the United States, and the pumps are of unusual design. The most striking feature is that they consist of only three stages, with the abnormal lift of 333 ft. per stage. The efficiency of the pumps under 1,000-ft. head is 62 per cent.

Repairing Electrical Switchboard Instruments

Instrument Failures — Detection of the Causes of Failure — Correction of Electrical and Mechanical Defects — Methods of Adjusting Deflection and Changing Scale Reading

By VICTOR H. TODD

WHEN an electrical instrument fails to indicate, the trouble may be one of four defects: (1) Lack of current or potential; (2) open-circuit in the instrument; (3) short-circuit of the measuring element; (4) mechanical difficulties. The first three are purely electrical defects and can be located by the proper use of additional instruments, while the fourth can usually be found by a close inspection.

For direct-current electrical troubles the instrument man should have a portable direct-current voltmeter,

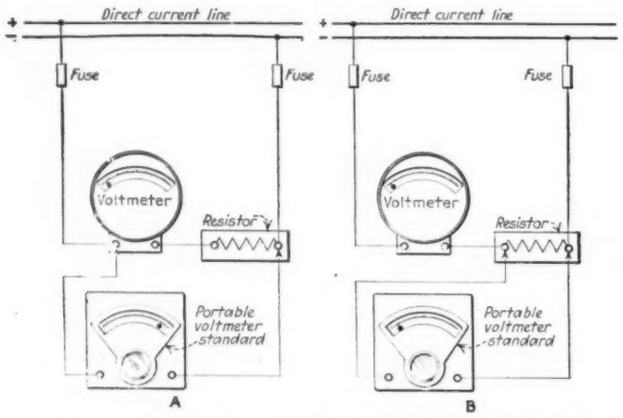


FIG. 1. TESTING A VOLTMETER TO DETERMINE CAUSE OF FAILURE

A—Deflection on the portable standard indicates that the trouble is not in the line, but either in the meter or the resistor. B—Deflection on both the portable standard and the instrument on test indicates that the trouble is an open-circuit in the resistor. Deflection on the standard meter only indicates a short-circuit or mechanical trouble in the voltmeter. No deflection on either instrument indicates an open-circuit in the voltmeter.

usually with several ranges that should duplicate or exceed the ranges of the voltmeters under his supervision. He should have a millivoltmeter with several interchangable shunts of the capacities likely to be encountered. For alternating-current work he should have a portable double-rating voltmeter for about 150 and 300 volts full scale; a double-rating ammeter for about 5 and 10 amperes full scale; a portable wattmeter with a double-current rating of 5 and 10 amperes and a double-voltage rating of 150 and 300 volts, and voltage and current transformers whose primary ratings correspond to the voltages and currents that may be encountered. Additional portable standards, such as power-factor meters, frequency meters, etc., may be necessary in certain cases. A small Wheatstone's bridge is also desirable but not essential.

For the mechanical troubles a kit similar to Fig. 1 should be used. This contains necessary tools such as large and small pliers, wrenches, screwdrivers, soldering copper, eye-loop, magnet cleaner, tweezers, soldering flux, etc. The soldering flux is an important item, as one of the first rules of instrument repairing is that fine wires or springs must never be soldered with any paste or flux containing the least acid. There are several acid-free compositions on the market that may be used, but an unexcelled paste is made by dissolving powdered rosin in alcohol and adding a little glycerin to prevent drying or caking. This must be used with thin wire-solder and a well-tinned soldering copper to produce perfect electrical connections. No acid or even sal ammoniac and zinc chloride should be used.

Voltmeter Troubles

Assume that a direct-current voltmeter suddenly ceases to indicate. The different steps in locating the trouble are illustrated in Fig. 1. The first point is to see if it is caused by line trouble. Select a portable standard voltmeter and connect it across the terminals of the non-operating voltmeter. No indication denotes line trouble, and the voltage should be tested nearer and nearer the bus or generator until the cause be found. Loose connections or blown fuses often prevent the meter from indicating. If there is an external resistor in series with the voltmeter, as in Fig. 1, connect the portable across the line sides of the voltmeter and resistor, as in Fig. 1A, to ascertain that the line voltage is on; then connect the voltmeter across the external resistor, as in B. If both the standard and the meter on test register, there is an open circuit in the resistor; no indication on either meter shows an open circuit in the voltmeter; indication on the portable standard alone shows short-circuit or mechanical troubles in the voltmeter.

If a portable standard voltmeter is not available, then low-power lamps (5 or 10 watts) may be used to advan-

FIG. 2. TYPICAL KIT OF INSTRUMENT-REPAIR TOOLS

tage, except that in some cases the lamps may not light owing to the high resistance in the voltmeter. Oftentimes, on low-voltage circuits of 110 or 220 volts, the experienced repairman will use his fingers as a voltage detector. This method is very rapid, but its continued use encourages carelessness that may end disastrously, and it should always be used with great caution or the habit abandoned at once.

If the voltmeter shows an open or short-circuit, it may further be confirmed by disconnecting one terminal and connecting the standard in series; no indication

shows open circuit in either voltmeter or resistor, and indication shows either a short or mechanical troubles in the voltmeter.

Electrical Defects in Other Meters

Breaks may be determined in the potential circuits of wattmeters, watt-hour meters, frequency meters, power-factor meters, reactive-factor meters, and synchronoscopes in identically the same manner, provided the other circuits of the instruments are functioning correctly. Short-circuits may be determined as in a voltmeter in the foregoing instruments, except those where the total impedance of the potential circuit is in the measuring element, as in the watt-hour meter. In this case, however, a mild short does not prevent registration, but causes the meter to read high, while a short-circuit of a large portion of the element eventually causes a burnout and open circuit.

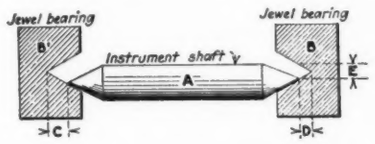


FIG. 3. SHOWING END PLAY AND SIDE PLAY IN AN INSTRUMENT SHAFT

Millivoltmeters are tested exactly like voltmeters, except that a portable millivoltmeter should be used in the test. Self-contained direct-current ammeters should be tested with a similar range portable, first by connecting in parallel to indicate the presence of current. If the ammeter shunt is burnt out, this closes the circuit through the standard meter, and the latter will indicate. If the disconnecting of the standard is accompanied by an arc upon breaking the circuit, it will show that the meter under test is open-circuited; but if disconnecting the standard produces no arcing, it will show that the shunt of the ammeter on test is intact and that there is either electrical or mechanical trouble in the moving element or its connections.

Inspecting for Mechanical Troubles

Assume that the original voltmeter has been proved intact electrically, but still does not indicate. First, wipe all dust or dirt off the cover and then remove it carefully. Give the pointer a gentle push with a match stick or toothpick to see if it is stuck. (Meter elements are usually alive and should be touched with caution.) Assume that it stays wherever it is pushed and will not return freely to zero. This indicates mechanical trouble in the element. Now, disconnect the voltmeter and remove it from the board.

Adjusting the "End Play"

One of the most important mechanical points in an electrical instrument is the correct adjustment of "end play." This is illustrated in Fig. 3, where an enlarged view is shown of the shaft with glasshard, pointed ends and sapphire jewels. The total distance $C + D$ that the shaft can move from end to end is called the "end play," and the distance E that the pivot can move from one side of the jewel to the other is called the "side play." End play and side play are usually only a few thousandths of an inch, and upon this detail depends the operation of the instrument. A most important rule of instrument repairing, and one that should always be followed, is never to tighten the jewel screws until they clamp or pinch the moving element; even one such setting may ruin the pivots.

Correctly designed jewels and pivots usually require only adjustment of "side play," which is done as follows: Lay the instrument on its back as in Fig. 4 and, grasping the pointer gently but firmly with either tweezers or thumb and finger, wiggle it gently back and forth, meanwhile tightening the jewel screw with a screwdriver a fraction of a turn at a time until the play is reduced to a few thousandths (about the thickness of a sheet of paper). Then holding the screwdriver firmly in this position without pressing down, tighten the jewel locknut with a suitable wrench.

It may seem superfluous to caution the repairman to ascertain that the pivots are actually in the polished recess in the jewel in making this adjustment, and not in a crack between jewel and mount; yet many pivots are ruined from this oversight.

Foreign Matter in Air Gap

Success in instrument work depends upon absolute cleanliness, for the greatest enemies of an instrument are iron filings and dirt; sooner or later they find their way into the air gap and stop the moving element. To inspect the air gap of a direct-current instrument, push a piece of white paper between the base and element and then, holding the instrument so that the light

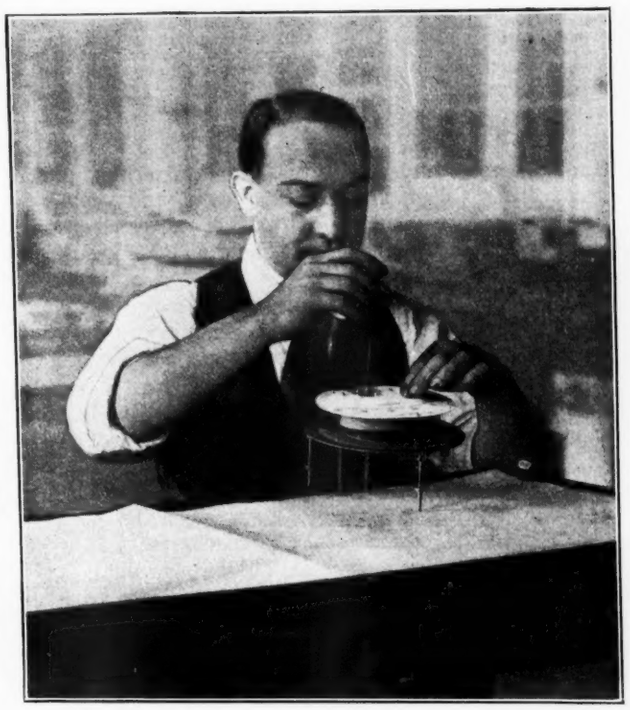


FIG. 4. ADJUSTING THE PLAY IN AN INSTRUMENT

shines on the paper, look through the air gap. A magnifying glass may be used to advantage, and the least piece of filing, hair, lint or dirt should be carefully removed. Iron filings can best be removed by using an iron wire and dirt or fuzz by using the tweezers or an ordinary chicken-wing feather. Other defects, such as loose wires or parts out of alignment, are easily discernible by a simple inspection and are generally repairable.

Practically all high-grade switchboard voltmeters, wattmeters and ammeters have fine control springs. Assume that a voltmeter has a damaged spring that must be replaced. Heat the soldering iron quite hot

(but not red), see that it is well tinned, and then grasping the spring with the tweezers near the soldered joint at its outer end, touch the hot iron to the joint only long enough to melt the solder; then pull the spring away. It may be necessary to unsolder the connections and remove the magnet and element from the base in order to get at the bottom spring.

After the outer ends of the springs are loosened, first the jewels then the jewel brackets should be removed; the inner turn of the spring may then be unsoldered and the spring removed. In replacing the

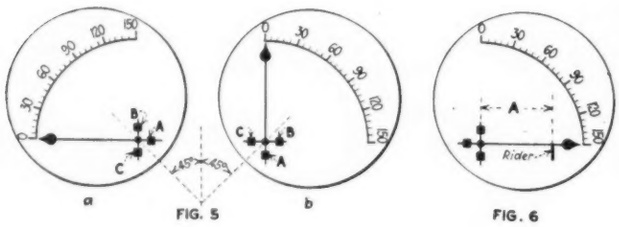


FIG. 5 FIG. 6

FIGS. 5 AND 6. BALANCING THE POINTER AND MEASURING THE TORQUE

Fig. 5. Balancing the pointer. The pointer should indicate zero in any position. (a) Place the meter on its side with pointer horizontal. Counterweights *B* and *C* have no effect on the balance in this position, and weight *A* may be adjusted to bring the pointer to zero. (b) Place the meter with pointer vertical. Counterweight *A* now has no effect on the balance, and *B* and *C* may be adjusted to bring the pointer to zero. Repeat both operations to be sure of the balance. Fig. 6. Measuring the torque of the meter springs. Adjust the rider on the pointer for full-scale deflection. The torque is the weight of the rider in grams times the distance *A* to the center of the shaft in centimeters.

spring, the inner and outer turns should first be tinned, using a little solder and neutral paste, and then the spring washed in benzine or alcohol to remove any trace of soldering paste. Then, holding the spring in place perfectly flat and with the turns evenly spaced, touch the ends with the point of the iron just long enough to melt the solder on both spring and support and secure good electrical and mechanical connection.

The brackets may now be reassembled and the jewels replaced, carefully adjusting the side play as before. Finally, the outer ends of the springs may be resoldered.

Balancing the Moving Element

A good instrument should always have the moving element in good mechanical balance; that is, the pointer should indicate zero in no matter what position the instrument be turned. To secure this various counterweights are used, such as threaded weights, solder, unrolling strips, sliding-wire weights, small screws, etc. The best instruments have threaded weights, but the principle of balancing is the same in all cases.

The first step is to lay the instrument flat on its back and set the pointer on zero. Then hold the instrument so that the pointer is horizontal as in Fig. 5a. Weights *B* and *C* now have no effect on the balance, and weight *A* should be adjusted so that the pointer again indicates zero; then, turning the instrument so that the pointer is vertical as in Fig. 5b, adjust either weight *B* or *C* until the pointer once more returns to zero. Recheck and adjust the other positions if necessary. The instrument should then be in perfect mechanical balance. Inability to secure perfect balance is often caused by flattened pivots ends.

After a final inspection the instrument may be retested and placed on the switchboard.

After the replacement of a spring, it may be found that the instrument is in serious error, due to a variation in spring strength. Or it may be desired to change the capacity of the instrument by changing the spring strength. In either case it is necessary to measure the "torque" or deflecting force of the instrument, usually expressed in "centimeter-grams." Turn the instrument so that the full scale mark is in a horizontal line with the pivot and then hang a small weight in the form of a rider on the pointer, until it deflects the pointer to full scale. This is shown in Fig. 6. Measure the distance *A* from the center of the jewel to the center of the rider in centimeters, using a pair of dividers if necessary, and multiply by the weight of the rider in grams. Their product is the torque of the instrument in centimeter-grams. In the absence of metric standards the torque may be calculated in inch-ounces, using a rider made from a known length of copper wire, the weight of which may be obtained from a copper-wire table, and reduce to centimeter-grams by multiplying the inch-ounces by the constant, 71.88. A torque of 1 inch-ounce measures 71.88 centimeter-grams.

Assume, for example, that a piece of No. 24 B. & S. gage copper wire one inch long produces a full-scale deflection at a distance of 2.25 in. from the center of the jewels. From a wire table we learn that No. 24 copper has a weight of 0.001223 lb. or $0.001223 \times 16 = 0.019568$ oz. per foot; or $0.019568 \div 12 = 0.00163$ oz. per inch. Multiplying by 2.25 in. gives 0.003667 inch-ounce torque. Multiplying by 71.88 gives 0.2635 centimeter-gram torque.

If the scale deflection is 90 deg. and two springs are used, then the torque of one spring will be one-half of 0.2635, or 0.137 centimeter-gram, for 90 deg., or

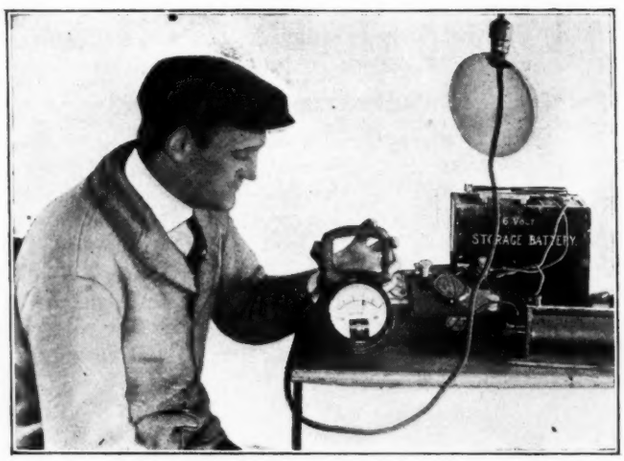


FIG. 7. DEMAGNETIZING AN INSTRUMENT

If a meter reads too high, the easiest way to reduce the deflection is to demagnetize the magnet gradually by means of a coil carrying alternating current, until the reading is correct.

0.5268 centimeter-gram for 360 deg., and these are the terms in which the spring should be ordered from the manufacturer.

If it is desired to double the deflection for a given current or voltage, springs one-half as strong, or 0.2635 centimeter-gram should be ordered; if it is desired to decrease the deflection to one-half, then springs twice as strong, or 1.0536 centimeter-grams, should be obtained. This refers only to instruments in which the torque is proportional to the current or

voltage applied. If a dynamometer-type meter is used, the torque increases as the square of the current or voltage, and in changing the scale reading the torque at the desired current or voltage should be calculated.

Adjusting the Deflection

Although some instruments may be equipped with special deflection-adjusting devices, the majority of instruments vary the calibration by adding or removing series-resistance wire or demagnetizing the magnet. If the voltmeter reads only a small percentage low, remove a few turns of resistance wire, resolder and note the results. Then figure how many turns must be removed to give the desired increase in deflection. If the meter reads too high, resistance wire may be added. But a much quicker way is to vary the strength of the magnet. To do this, use a coil of wire carrying alternating current and bring the coil closer and closer to the instrument, as shown in Fig. 7, thus gradually demagnetizing the magnet until the instrument reads correctly.

A coil of No. 24 B. & S. gage copper wound with 400 turns on a mandrel 6 in. in diameter and connected to a 110-volt alternating-current supply forms a good demagnetizing outfit.

Magnetizing the Magnet

After repairing an instrument it must be adjusted to give the correct deflection. The customary way is to saturate the magnet, and then demagnetize it till the meter reads correctly. Where a quantity of magnets are to be magnetized, an induction magnetizer may be used, as shown in Fig. 8. This particular magnetizer

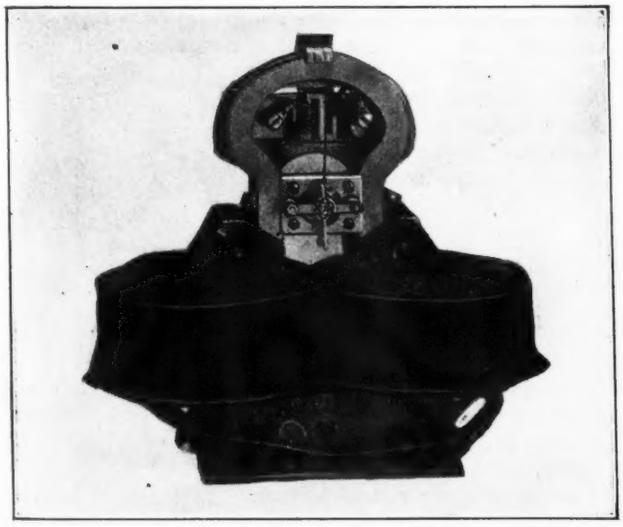


FIG. 8. MAGNETIZING A MAGNET BY INDUCTION
The magnet of the instrument is placed pole to pole with a powerful electromagnet excited with direct current.

has two coils with 1,200 turns of No. 28 wire, connected in parallel and is connected for only a second across 110 volts direct current.

For larger magnets and where full saturation is desired, the magnet complete with its element should be removed and wrapped with 15 or 20 turns of heavy stranded wire of about the equivalent of a No. 8 or 10 B. & S. gage wire. This wire is carefully wound around the magnet, as shown in Fig. 9, care being taken not to damage the pointer, and then this wire is shorted several times in rapid succession directly across the terminals of a good storage battery, preferably of the automobile-starting type, or its equivalent. This saturates the magnet and it should then be unwound, reassembled in the instrument and demagnetized by the process just described. After repairing the instrument, the old scale marking may not be correct, but it is a simple job for a repairman with a little drafting ability to lay off a new scale, locate the main points by comparison with a standard and mark in a new scale, using a set of rubber stamps for the number outlines and filling in with black ink. Where a more presentable job is required, the manufacturer can furnish blank dials that may be placed on the instrument and the main points, say 8 or 10 of them, located with a pencil dot by comparison with a standard. This scale is returned to the manufacturer, who marks in the main and intermediate points in ink, after which the scale is replaced on the instrument and rechecked. This not only saves re-calibration and transportation charges, but also prevents damage to the instrument during transit, and remarkable accuracy may be obtained and maintained in this simple manner.

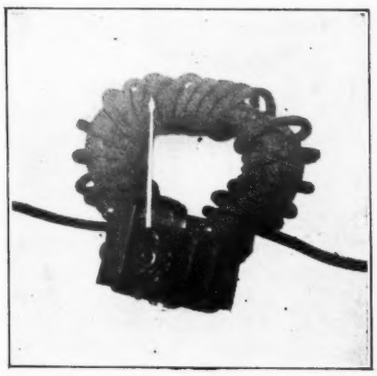


FIG. 9. MAGNETIZING BY WRAPPING
In case a suitable electromagnet is not available, the magnet may be saturated by wrapping with a cable, as shown, and connecting the latter for an instant several times in succession across the terminals of a storage battery.

Proposed to Make it Unlawful to Enter Boiler Under Pressure

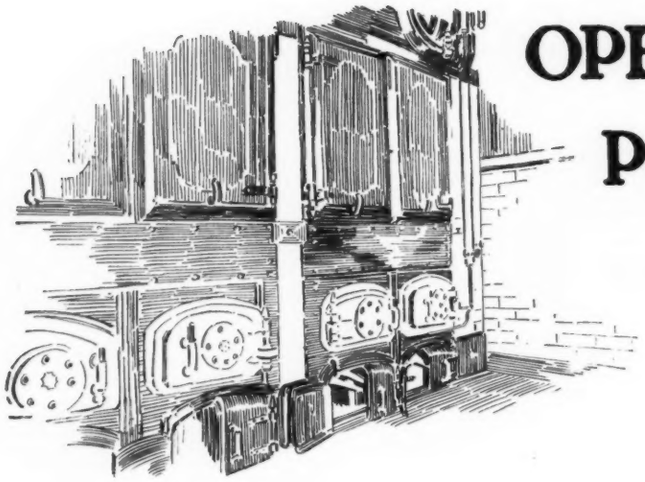
An unusual boiler failure was described on page 999 of *Power* for June 21. Shrinkage strains set up by an old welding repair had caused a furnace sheet to crack with a loud report while an inspector was working in the firebox. Perhaps such an accident is what a Colorado legislator had in mind when he wrote "House Bill No. 95," which starts as follows:

A Bill for An Act to Regulate the Blowing Off of Steam Boilers. Be it enacted by the General Assembly of the State of Colorado:

Section 1. It shall be unlawful for any railroad company or any person, firm or corporation, using steam boilers, to command, order or permit by themselves or their agents any of their employees to enter any steam boiler, firebox, or smoke chamber thereto, for the purpose of repairing or cleaning the same or for any other purpose *when the same is under steam pressure.*

This is an actual bill, copied here exactly as it was printed, except that the last seven words have been put in italics. There are five more sections of the bill, which are designed to set up further restrictions against ordering a man to enter a boiler under pressure.

The intentions of the man who wrote the bill seem to have been good, and indeed, mistakes will happen; but whatever becomes of this bill it is to be hoped that no man will ever try to get inside of a boiler without at least reducing the steam pressure to, say, about fifty pounds.



OPERATING SMALL POWER-PLANT BOILERS

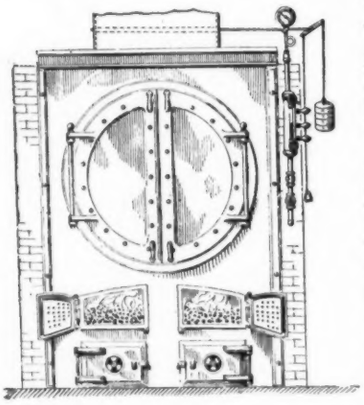
By

William W. Edson

MOST engineers are able to keep their engines running, take indicator diagrams, set the valves, etc., but some do not take much interest in the boiler room, and so long as the steam does not drop sufficiently to slow down the engine, they seem to be satisfied. However, every engineer should realize that boilers are expensive, that good firemen are hard to get and to keep, and that most power-plant waste occurs in the boiler room. The following suggestions may act as a guide in working out a plan to put the boiler plant on a proper operating basis:

Care and Operation

From time to time have the feed water analyzed and use the proper boiler compound if any is necessary. Usually, it is best not to put boiler compound into the heater. Each Sunday the heater should be washed out, and once a month the trays (if so designed) should be removed and cleaned. The hotter the feed water the more impurities will remain in the heater. Once a month the boiler should be cleaned, in some cases oftener. Take it off the line and allow it to cool slowly. This is done by closing the damper and the ashpit doors and partly opening the firedoors. Never open wide the damper when the firedoors are open. This would cause strains in the boiler and its setting.



When the boiler is cold, pull the dead fire and clean the ashpit. Drain the boiler of water. Never blow down the boiler while under steam pressure.

Usually, time will be saved by draining the boiler and then removing the blowoff valve. This allows the pipe to be cleaned out when necessary. Immediately, cut new gaskets and oil them for the valve flanges and clean the flange bolts and nuts.

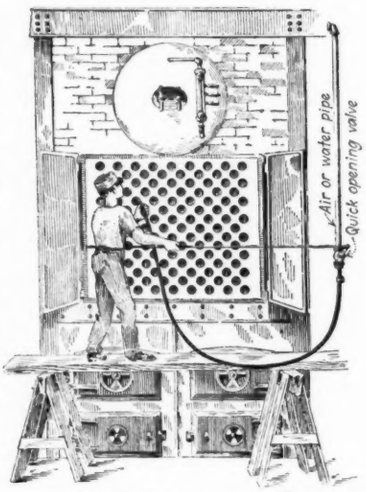
If water-tube boilers are used, remove four or five handhole plates on the bottom row in the rear. The tubes are then cleaned from the front end as quickly as possible. A safe and rapid procedure is to have two men operate the tube cleaner, while all other help available is kept busy removing handhole plates, cleaning them, fitting new gaskets (painted with graphite and oil) and replacing the plates. Never have any more plates off at one time than is necessary.

Clean the tubes, beginning with the bottom ones. The bottom four rows only should be cleaned each month, and at least once in six months all the tubes and the steam and mud drums should be cleaned.

Use the finishing head on the cleaner where possible. This may have to be preceded by the drill head.

Support a rod across the front of the boiler and connect it to a lever-operated throttle valve on the water or air pipe connecting to the turbine cleaner. The workman can then start or stop the cleaner without leaving his position.

After cleaning, fill the boiler and pump up with water pressure to 110 lb. Search for water leaks. On this water test do not pump up the pressure until the safety valve opens, since this may fill the discharge pipe. If hammering around a handhole plate that is leaking, and if tightening the caps does not stop the leak, drain the boiler of water. There is either no gasket or a bad one on the plate, or else there is a piece of scale caught under the plate. In filling or draining a boiler, open the upper gage cock or other valves to permit air to escape. Scale in a tube may prevent free water circulating through it, thus making it likely to fail. Scale may cause a tube to blister and split. Also, scale causes a lowering of efficiency, since it is an insulator of heat.



When the boiler is opened, some of the upper tubes may be flushed out with a strong stream of water.

Inspect the setting, pack valves and unions, as required, and make any other necessary repairs. This work may be done while the boiler is being cleaned.

After the boiler is in first-class shape, fill with water to the running level and place wood on the grates ready to start the fire.

If the boiler is to be shut down for six or seven months, drain it and dry it out. Put pans of quicklime in the drums. However, for shorter intervals keep the boiler full of water. This is to prevent pitting at the water line. When ready to get up steam, lower the water level to one-half glass and bring up the temperature of the walls very slowly. Test all gage cocks, blowoff valves, water column, safety valve, etc. When the pressure is the same as on the other boilers, open the line valve very slowly. Never allow the difference to be more than 10 pounds.

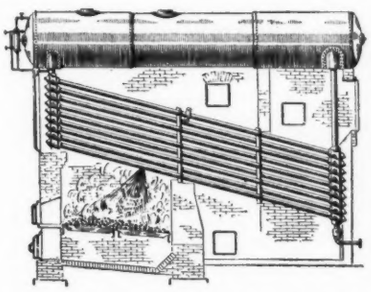
If, at any time, the water becomes low and has been out of sight for some time, do not start the feed pump and do not shut down the engines or turbines. Pull the fires, if advisable, and then open the damper and the firedoors. If pulling the fires would cause too much heat, throw wet ashes on them, shut the damper and the ashpit doors, and open the firedoors. When the boiler is cold, fill with water and put on water pressure, test and hunt for leaks.

When a boiler has a good fire under it do not shut the damper and fire and ashpit doors tight, as there is danger of a gas explosion.

Do not remove the latches on the firedoors. They are to prevent the fire from being blown out into the room in case of a tube explosion.

The soot on the tubes acts as insulator of heat and should be removed at frequent intervals. Inspections can be made through the hollow staybolts of some types of boilers by removing the plugs. Fire should be seen in nearly all the front holes. Do not fail to replace these plugs.

Use as little oil as possible in the steam pumps because there is danger of the oil coming over with the exhaust steam to the heater and thus getting into the feed water. Oil in a boiler may settle on the heating surface and keep the water away from it, thus allowing the shell or tube to burn or blister. Also, oil will cause the tube ends and other joints and seams to leak. The temperature of the feed water is kept at a maximum by passing all available exhaust steam into the heater, by running the feed pumps at a steady, even rate, by keeping the heater clean, by keeping the float valve in good shape to prevent the heater from overflowing or running dry, and by running all the hot water available into the heater.



Boiler Setting

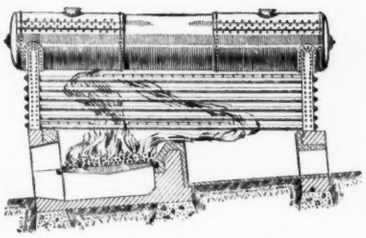
The greatest field for improvement in a power plant is found in the combustion of fuel in the boiler furnace. One of the most important items in this connection is the volume and the way in which the air is admitted. Before any definite improvement can be started, the boiler setting must be tight.

Once a month the setting should be examined for air leaks with the aid of a candle. This also means the space between the boilers. Different loads, different intensity of fire, and the cutting in or out of service of a boiler will cause its setting to crack or to check. These cracks should be filled with asbestos cement or a boiler covering. The bricks are porous and should be painted to keep out the air. Pack the joint between the headers or water legs and the boiler setting.

Every pound of air that leaks in the furnace at the wrong place must be heated from, say, 70 deg., to the temperature of the furnace. Obviously, this excess air is going to absorb heat units that should be used in making steam.

The walls of the furnace and the bridge wall must be kept in good condition. These walls are built of firebrick bonded together with a good fireclay or a furnace cement.

Baffle walls are used so as to cause the gases to follow a longer path in sweeping over the tubes, thus giving a longer time in which the heat can be transferred to the water, and also exposing a greater area of tube surface to the action of the gases. A leaky baffle will allow the hot gases to short-circuit to the stack without giving up much heat to the water in the boiler, and obviously the boiler capacity and efficiency will be materially reduced. Also, the stack temperature will be high, which likewise means a large loss.



If the baffles are not large enough, the gases will not follow their proper path, and the results will be similar to those produced with leaky baffles. If the baffles are too large, the gases will be choked down and the draft will be insufficient.

Methods of Firing

There are three methods of hand firing. With the spreading method coal is spread evenly over the entire grate surface. With the alternate method one side is fired at a time. The third is the coking method, and is very efficient if used with a hand-fired furnace. Coal is piled on a dead plate at the front of the grates and allowed to coke. The volatile gases are driven off and are burnt as they pass over the hot fire on the grates. Finally, the coke is pushed back onto the grates, and a fresh charge of coal is put on the dead plate.

The coking method calls for more work than the other two, and so the first and second methods mentioned are used. The fire must be kept the same depth throughout. The back of the grates and the space between the firedoors must be especially watched. The thickness of the bed depends on the coal, load and draft.

An air-hole will cause that part of the grate to be of no use in burning coal and allow large quantities of cold air to sweep in, which cools the fire and the boiler, as well as uses heat in heating the air to the stack temperature.

As coal burns, it leaves ash on the grates below the fresh fuel, thus protecting the grates from the intense furnace heat. The ashes should be dropped into the ashpit by a slight shaking of the grates. When the slice bar is used the ashes are brought up to mix with the burning fuel, where it fuses and clinkers. If a clinker does form, lift it and gently pull it out so as to prevent further fusing of the remaining ash.

If the load is heavy and the fire has to be kept at such a high temperature that the coal fuses and clinkers, the area of the grate surface should be increased. If the load is light and a full even fire cannot be kept on

the grates without popping the safety valve, some of the grate surface should be covered. Do not burn less than 10 lb. of coal per hour per square foot of grate surface. If the coal is of the long-flaming kind, and the flame strikes the cold tubes, which cools the gases below the ignition point before they have a chance to burn, the boiler should be raised or the grates lowered. Too high a setting may cause a slight loss due to radiation, but this should be small if the setting is painted.

Although there may not be air holes, one part of the fuel bed may be thicker than the other. Thus, the thin portion may admit large volumes of air, resulting in a low percentage of CO_2. The thick portion may not be getting enough air and may be producing CO. Thus the flue-gas analysis would show a low CO_2 percentage and at the same time some CO. The final combustion may take place between the tubes, thus raising the stack temperature, and cause a loss. This shows the reason for maintaining an even fire of the same depth throughout.

The ashpit doors should ordinarily be open and the draft regulated by the damper which can be more closely adjusted. If the ashpit doors are closed and the damper is open, there is a vacuum set up in the furnace which will draw in air through cracks if there are any.

Determine the excess air needed for various loads and keep to that amount. This excess varies with the size and kind of coal, kind of furnace and grates, depth of fire, method of firing, draft, etc.

Smoke should be avoided to prevent the deposit of a heavy coating of soot on the tubes. The smoke itself is not much of a loss since excess air and unburnt gases will cause a much greater loss. Smoke may be caused by lack of air. If, however, the flue-gas analysis shows not over 12 per cent CO_2 and practically no CO, the air volume may be assumed to be all right. Lack of furnace temperature may cause smoke. In this case install an arch over all or part of the grates to throw back the heat onto the fuel to burn the gases. The gases may not be mixing properly, owing to uneven fire or to bad furnace design. Sometimes a mixing arch is needed. Also, if the combustion chamber is too small and the boiler set too low, the gases will be cooled before they are burnt, thus causing smoke.

The best coal for the furnace is that which will produce the heat with the least amount of excess air. The best draft to use is that which gives the highest CO_2 with the least CO. A draft gage will show that something is wrong before the steam gage will indicate a falling pressure. A decreasing draft gage shows airholes. An increasing one shows that the fire is too thick or that there are clinkers. The effect of wetting the coal is that there is a certain amount of heat lost due to the evaporation or decomposition of water; however, fine coal which might otherwise pack, may be loosened and burn freely. The question of wetting fine coal will have to be settled by experiment.

To Determine Proper Methods of Firing

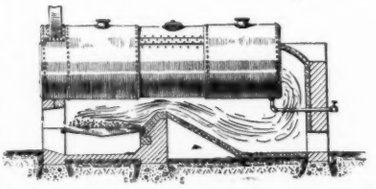
To determine the proper method of firing, start out by having clean tubes, clean combustion chamber, tight setting, brickwork painted, cracks filled between the headers and setting, clean fires, clean ashpits, baffles in good shape and everything in good order.

Have a large pile of clean coal as ordinarily fired. A helper and a good fireman will be needed. Select a time when the load is normal and steady and have the gage glass one-half full and have the feed-pump speed adjusted to hold the water at this level.

Give the fireman a pair of smoked glasses so he can closely observe the condition of his fire.

Place the hoe on its side and chalk off a scale in inches. Mark off a scale in inches on the door liner. Set up the gas analyzer right at the last pass. Start with a fire four inches deep throughout. Test the depth of the fire at various places with the hoe. Watch the back of the grates and between the doors, and have the damper nearly wide open.

While taking a gas sample and analyzing it, have the helper note the fire thickness, draft, steam pressure and the time. If less than 12 per cent CO_2 is obtained, build up the fire and start another test. Duplicate the foregoing conditions as closely as possible, but reduce the draft somewhat. Keep repeating these tests until 12 to 13 per cent CO_2 is obtained. At these high values also test for CO and note when it begins to become important. Repeat the entire series of tests under the same conditions, but have the fire five inches thick. Likewise try various other thicknesses of fires. If a quick analysis of the gas can be made, the whole series of tests should take but a few hours.



The process should be repeated for various loads. The thickness of the fire that will best carry the load and the draft for this depth of fire that gives the most CO_2 with the least CO are the results wanted.

Post the results in the boiler room and make the firemen follow instructions. Check the instructions from time to time. The results of each test should be plotted as curves; thus, per cent CO_2 plotted against inches draft. There will be a curve for each depth of fire. This sheet will be for one certain load. Make similar sheets for different loads.

Plot the inches of draft against the depth of the fire where the curves show the maximum efficiency points (max. CO_2 and min. CO) as taken from the charts. There will be a curve for each load. Plot a curve showing the best thickness of fire for each load. Data from these last two curves should be hung in the boiler room for the guidance of the firemen.

A review of losses in a power plant shows the following:

Coal lost in loading and unloading railroad cars; coal lost in loading and unloading wagons; coal lost in storing; coal mixed with ashes while cleaning fires and thrown on the ash pile; coal sifting through grates; unburned coal in ash; unburned coal drawn through firedoors during cleaning; losses due to banking fires; coal stolen from car and pile.

Excess air fed to fires; excess air due to uneven or bad fires; excess air due to cracks in boiler setting; excess air admitted through firedoors; heat used in heating cold air to furnace temperature; heat lost in chimney gases; heat radiated from boiler setting and stack; heat used in evaporating moisture in coal and air; heat lost due to incomplete combustion; heat lost in excessive stack temperatures; heat lost due to scale and soot on boiler tubes; heat lost in radiation from boiler surfaces; heat lost in popping safety valve; heat lost in blowing down boiler; heat lost in pipe friction and pipe radiation, in steam condensation and steam leaks.

Jacob M. Spitzglass

Inventor of the Republic Flow Meter, for Which He Has Been Awarded the Longstreth Medal of Merit by the Franklin Institute

SIXTEEN years ago Jacob M. Spitzglass brought his family over from Russia and got a job as a sweeper in a Chicago flour mill. He stayed there for only two weeks, however, because he didn't know the English language very well, and his employer apparently sized him up as "just another ignorant foreigner" and discharged him. Today he holds the degree of M.E. from Armour Institute, is vice-president and consulting engineer of the Republic Flow Meters Co. and has recently been awarded the Edward Longstreth Medal of Merit by the Franklin Institute, "In consideration of the novelty of recording electrically the flow of liquids in pipes and the mechanical simplicity and excellence of this measuring apparatus."

JACOB M. SPITZGLASS

The rise of an apprentice boy to success is a fine thing, but the story is so often told nowadays that it no longer has of itself an overpowering interest. The story of Spitzglass' life, however, is one that is seldom told, for he is of that rare type known as "a middle-aged success." He was born in a little country town in Russia in 1869 and received the religious education that was supposed, at the time, to cover all a young Russian's requirements. This included very little knowledge of mathematics, geography or history, with the exception of that given in the Bible. At the age of 16 he was considered a learned man in theology, but he longed to take up more practical subjects. The proprietor of a private school took an interest in him and gave him a year's schooling, against the violent opposition of his parents, but had to close the school for lack of pupils. Then, being denied admission to the high school at Kiev on sectarian grounds, he gave up his fight for an education and went to work in his father's business, which consisted of a primitive flour mill on the falls of the River Russ.

In 1904 conditions in Russia became intolerable and he decided to emigrate to the western part of Europe. He spent several months in Vienna trying to enter the mill-construction school, this having been his desire through all the years he had followed the flour-mill business. His family, consisting of his wife and two sons, joined him in July, but as he had found no employment and did not want to go back to Russia he finally emigrated to the United States, arriving in Chicago on Oct. 4, 1904.

The financial means of the family were limited, as the business in Russia could not be liquidated, and only meager help for the first three years came from his father and brothers, who retained the mill. Having the desire to accomplish something in mill construction, he sought employment in the flour mill of the Star & Crescent Milling Co., in South Chicago. He was given work as a sweeper there for two weeks, but his lack of knowledge of the language and other limitations made him of little value to the place and he was soon discharged.

At this time he heard of the Armour Institute of Technology and saw his chance to obtain the education that he had desired from an early age. He started immediately to prepare himself to enter the institution, taking up for six months a study of the English language, algebra, geometry, history of the United States and a little geography. In August, 1905, he approached Dean Monin of the Armour Institute and explained his condition and his lack of time for preparatory work. He was then nearly thirty-seven years old. Dean Monin sized up the situation and permitted him to enter the school the following September, giving him the opportunity to make up the back credits as he could. After attending the institute for four years, he graduated as B. S. of M. E. in 1909 and received an M.E. degree by submission of a thesis in 1912.

It was a hard task made more difficult by his limited knowledge of English and the necessity of supporting a family. Probably there was never a student who put in the hours Spitzglass did at his work and his studies. Twenty hours a day with four hours' sleep was nothing unusual. The wonder is that he was able physically to carry through such a program and, at the same time, to establish a record as a brilliant student.

In his search after truth he often cornered the professors and stuck to them until he got what he was after. This was sometimes embarrassing to his teachers, as once when he asked a stiff question in class and was told to come after hours for the answer; the professor expected to look it up in a book, but upon returning, saw his questioner waiting for him and slipped out through the back door to his home. Spitzglass saw him and got there first, however, and his "proff" had to own up, opened his textbook and helped him puzzle out his question.

His Practical Experimental Work

After graduation, Spitzglass went with the Northwestern Gas Light and Coke Co., now known as the Public Service Company of Northern Ilinois. His work consisted of plotting maps of street mains in Evanston and Oak Park. Not long after that he entered the employ of the Armour Glue Works and remained with this company for about a year and a half, being employed in the engine room testing steam engines and also experimenting with the measuring of the flow of steam to the various lines of the concern. At the end of this time he was engaged by the People's Gas, Light and Coke Co. to do experimental work, his training at the Institute and his subsequent work having shown that he was eminently qualified in this line. With the gas company he made an enviable reputation and remained with them about seven years.

His first experiments were on the flow of gas in pipes to determine the drop of pressure due to friction. In 1912 he read a paper before the Illinois Gas Association, in which he gave the results of these tests and included a series of charts for determining the capacity of pipes and the friction drop in the lines. The gas company prepared enlarged copies of the charts and distributed them free of charge to the profession at large. The charts and formulas presented in the paper were the basis of the Spitzglass slide rule and flow computer, developed in 1914. This rule was adopted by the American Gas Institute and is now used extensively.

At this time the engineering department of the gas company was exceedingly interested in a new development of using superheated exhaust steam for gas-making. This process was original with the company and proved a great success from the very start. Not only was there an increase in efficiency due to the use of exhaust steam, which otherwise would be wasted, but there was also a tremendous increase in the capacity of the gas machine. An experimental plant was installed at Blue Island, which demonstrated these contentions, and eventually Spitzglass was sent to the Division Street station to compare the efficiency obtained with exhaust steam on six units with that resulting from the single experimental unit. While the same economy of operation was obtained at the larger plant, the increase in capacity did not become evident, because there was no means for measuring the amount of exhaust steam used and there was no way of telling whether each machine was taking the right amount. At this juncture Spitzglass developed a primitive device for indicating the flow of steam to each machine, and the increased capacity was at once evident. This work was continued, and after leaving the company he perfected a flow meter for measuring the exhaust steam to the gas machine. These instruments are now employed at stations of various gas companies where exhaust steam is used for making gas. In October of 1914 a paper was presented at the annual meeting of the American Gas Institute, giving the details of this work, the title being "Methods and Facilities for Specifying and Testing Blowers, Also Measuring Air and Steam Supply to the Water Gas Generator."

In 1914 Spitzglass was made chairman of the gas works auxiliaries committee of the American Gas Institute and rendered a comprehensive report accompanied by charts at the annual meeting in San Francisco. The report dealt particularly with the pitot-tube method of measuring the flow of gas, being based on tests made by him and other members of the committee and containing recommendations in regard to the use of gages and pyrometers.

In 1915 there was begun another series of experiments to measure the flow of gas from the individual machines at the Pitney Court Station of the gas company. These experiments lasted over a year, and a written report was rendered in a paper to the American Gas Institute at the Chicago meeting in 1916.

While at the Armour Glue Works in 1910 Mr. Spitzglass obtained the experimental instrument of Professor Gebhardt for measuring the flow of steam and developed it commercially. This meter is now manufactured by the Republic Flow Meters Co. under the name of the Gebhardt steam meter. The experimental work on the electrical method of measuring the flow of fluids was begun in 1913 in the works of the Republic Flow Meters Co. As Spitzglass was in the employ of the People's Gas Co., he devoted evenings, Sundays and holidays to laying out the principles for continuation of the experimental work and the factors relating the flow of fluids in pipes with the flow of electric current through a conductor. The first meters of this kind were made in the latter part of 1914 and quite a number were sold during the next two years.

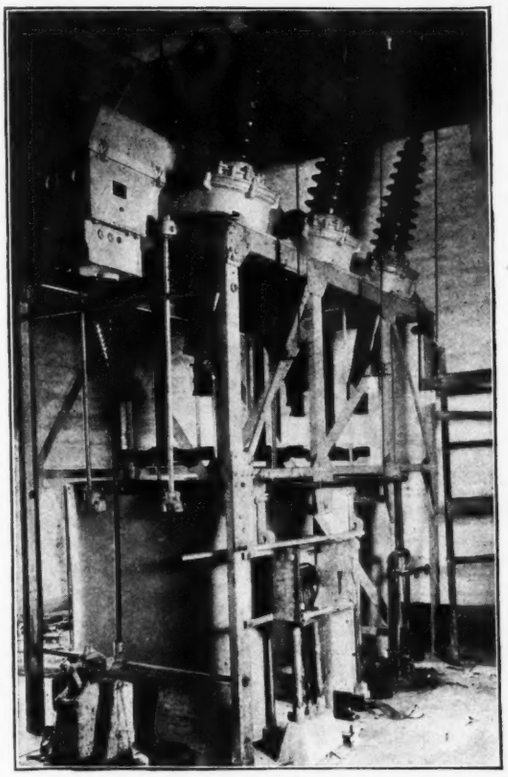
The Work that Brought Him the Medal

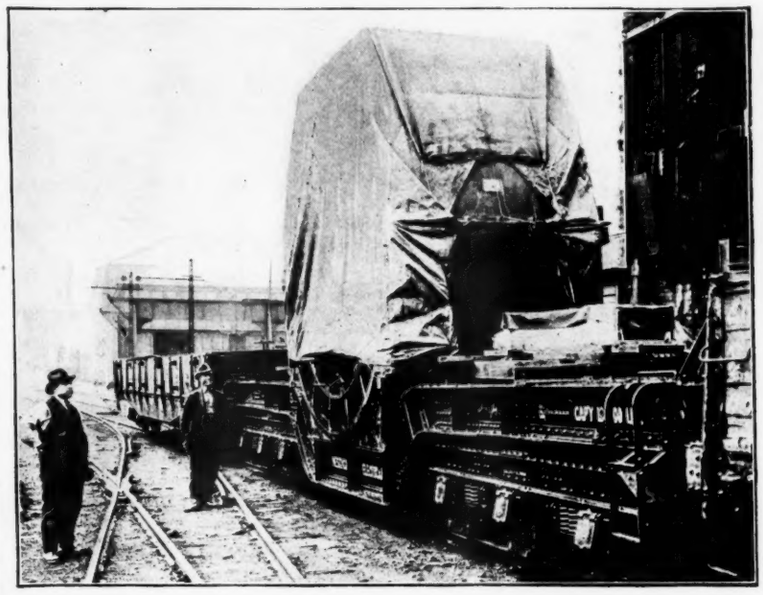
Some defects developed, however, and it became apparent that unless the meter could be improved to give continued accurate service, its manufacture would have to be discontinued. In 1917 Spitzglass left the services of the gas company and gave his entire time to the problem. The most important accomplishment at that time was the design of a special seal, which proved to be the very thing needed to insure the success of the meter. The procedure of the experimental work in this line and all the developments that followed are given in much detail in a paper read before the American Society of Mechanical Engineers in the summer of 1919 at Detroit. It was for his work on this meter that he was awarded the Longstreth medal of the Franklin Institute. It is a token of merit well deserved.

During this period he naturally became interested in the various engineering societies. He is a member of the American Gas Association, the American Society of Mechanical Engineers, the Western Society of Engineers, the Illinois Gas Association, and the Pacific Coast Gas Association. At this writing he is vice-president and consulting engineer for the Republic Flow Meters Co. and is still consulted by the gas company along the lines of work he conducted when in their employ. He is as honest and sincere as in the old days and works as hard as ever. Even now nothing would suit him better than to take up an advanced course in thermodynamics, his favorite subject while at college.

A siphon that carries 600 cu. sec.-ft. of water across a valley to the Kern River No. 3 plant of the Southern California Edison Co. The head is 320 ft. at the bottom. The thickness of the steel varies from $\frac{3}{8}$ in. at the top, where the diameter is $9\frac{1}{2}$ ft., to $\frac{3}{4}$ in. at the bottom, where the diameter is $8\frac{1}{2}$ ft. Three expansion joints are used.

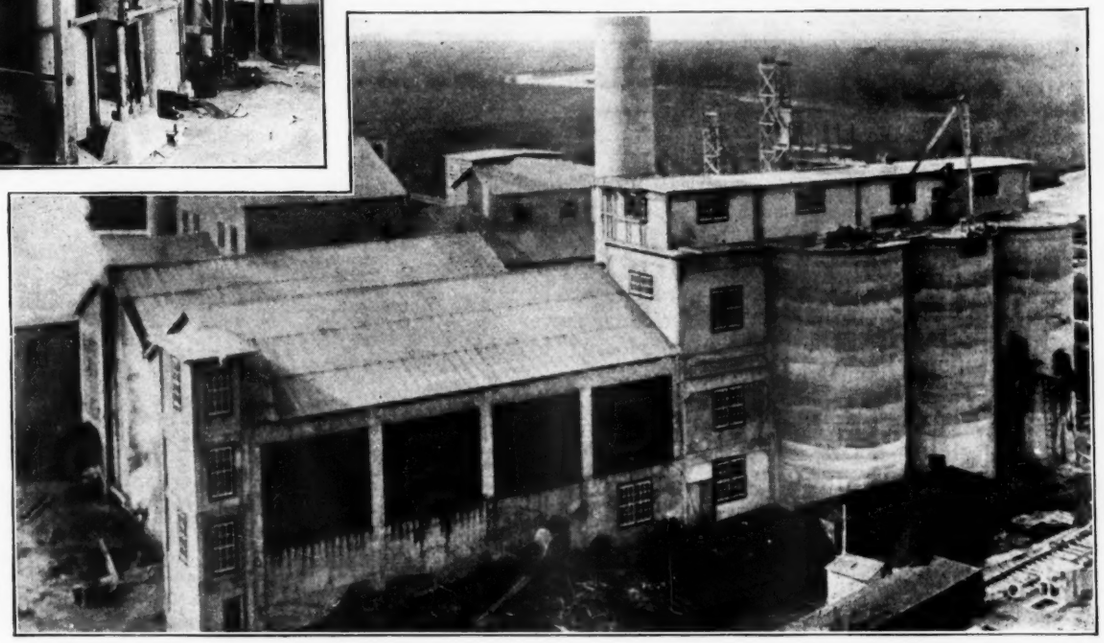
The special 95-ton car shown below was used by the Westinghouse company to carry a big stator, which was about 16 ft. high and 8 ft. wide, and weighed $55\frac{1}{2}$ tons. It is part of a 25,000-kw. turbine generator for the Gold Station of the Brooklyn Edison Co.





A 70,000-volt oil switch recently put into service in the Kern River No. 3 plant.

A group of six concrete coal-storage bins built into the power house of the Nebraska Cement Co. D. C. Findlay was in charge of the design and construction. The inside dimensions of the bins are 26 ft diameter and 51 ft. height. The capacity of the six bins is 3,500 tons.



Water-Power Developments in the United Kingdom

By JOHN B. C. KERSHAW

THE last year has not been remarkable for any striking progress in the development of water-power for industrial or domestic purposes in the United Kingdom. Much necessary investigation of the engineering and financial aspects of the subject has been carried out, however, not only by the committee appointed by the Board of Trade in June, 1918, to study the question, but also by private and public bodies.

The most advanced of the new proposals for water power development are those relating to North Wales. Here the North Wales Power and Traction Co., in conjunction with the Aluminum Corporation, have already developed 10,000 kw. and are transmitting electricity at 10,000 and 20,000 volts, by overhead lines, to the various towns located in the Conway Valley.

Provisional agreements have been entered into with the Urban District Councils of Colwyn Bay, Llandudno, and other coast towns of North Wales, for a supply of current for lighting purposes at 33,000 volts and the necessary transmission-lines are now in course of erection. It is hoped to have the line for supplying Colwyn Bay ready for use by June 30 of the present year.

Two distinct schemes of further electric-power development in North Wales were considered by the Electricity Commissioners early in February, their promoters being the North Wales Power and Traction Co. and the Chester Corporation, respectively.

The whole scheme of development planned by the former organization will yield 137,000,000 kw.-hr. per annum, and it is considered by the promoters that this would be adequate for the needs of the whole of North Wales for many years to come.

It is believed that the price charged for bulk supply under the new scheme will not exceed 2d. per unit.

The second scheme, which has been prepared by the Corporation of Chester, embodies the erection of a 10,000-k.w. steam-generating station at the mouth of the River Dee; the development of twelve low-fall water-power stations on the same river between Llangollen and Erbistock; the development of a small water power station on the Clwyd; and the linking up of these new stations with the existing water-power stations at Dolgarrog and Cwm Dyli.

The steam-driven station at the mouth of the Dee would be equipped with 5,000-kw. turbo-generators and a modern boiler-plant provided with mechanical coal- and ash-handling equipment; while the twelve low-fall

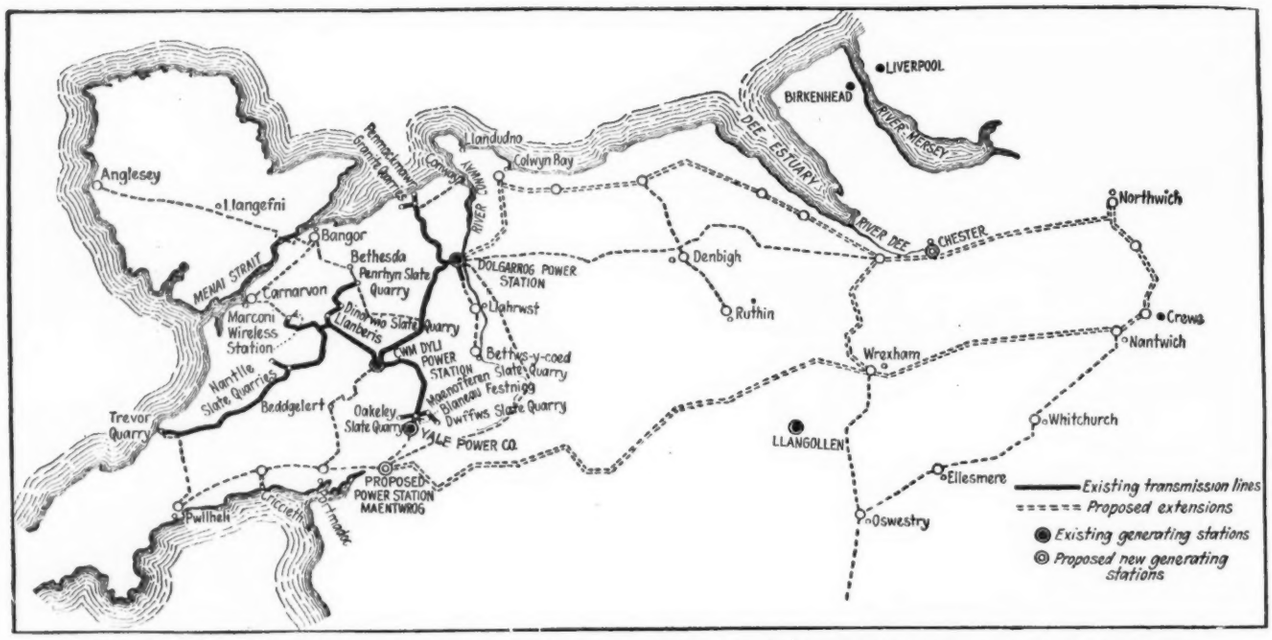


FIG. 1. MAP SHOWING PRESENT AND PROPOSED ELECTRIC TRANSMISSION LINES IN NORTH WALES

power stations on the Dee, with heads of only 9 to 37 ft., would be equipped with turbines connected to direct-current generators and would produce 11,800 kw. in the aggregate.

The estimated capital expenditure upon these stations, and the power to be developed would be as follows:

	Kw.	£	Cost per Kw., £
Clwyd	1,000	74,000	75
Dee (water)	4,300	322,500	75
Dee (steam)	10,000	275,000	27½

The Dee water-power scheme, however, would ultimately be increased to 11,800 kw. capacity, at a total cost[1] of £885,000.

Developments in Scotland

The original power developments at the Falls of Foyers in Scotland, were planned and carried out by the British Aluminum Co. in 1895.

At Foyers, 3,500 hp. was obtained, and larger works at Kinlochleven were constructed by the same company

[1]On May 15, 1921, the pound sterling was equivalent to $4.00, U. S. currency.

in 1905-6, increasing the power available by 25,000 horsepower.

By means of a concrete dam three-quarters of a mile in length and 86 ft. high in the center, the water of three previously existing lochs in this area has been thrown into one, and the water from a catchment area of 60 square miles has been impounded in one large lake, about 1,000 ft. above the sea level.

Very large developments of power from other watersheds in this area of Scotland were planned by the British Aluminum Co. in 1917, but the bill embodying these plans met with so much opposition in the House of Lords that it was withdrawn. The scheme has been modified and is to be reintroduced during the present year.

Proposed Developments in the Grampians

The first interim report issued by the Water Power Resources Committee (February, 1919) contained a general description of nine Scotch schemes of water-power development, which, in the opinion of the committee, seemed capable of economic exploitation either by public bodies or by private enterprise. The development of the water power of Loch Ericht, Loch Laidon, Loch Rannock and Loch Tummel appears to be the only one of these with which any progress has been made during the last year. In this case (as in North Wales) private enterprise seems likely to be granted the necessary powers, since the Dundee Corporation, with true Scotch caution, has decided that the financing of such a large scheme is beyond its means and borrowing capacities. A company named the Grampian Electricity Supply Company has, therefore, been promoted with the object of developing the water-power resources of

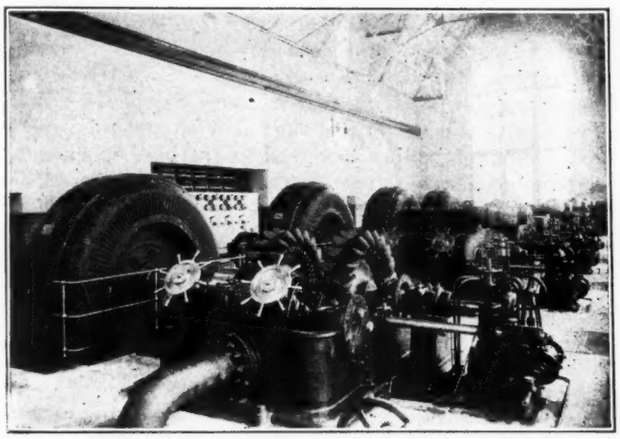


FIG. 2. DYNAMO ROOM CWM DYLI POWER STATION

the watershed area that drains into these four lochs, and a plan has been drafted that will entail the expenditure of between £1,000,000 and £4,000,000, before it is completed.

A franchise is sought for the erection and maintenance of five generating stations, located at the following points: (1) On the north shore of Loch Rannock in the parish of Fortingall; (2) near the junction of Allt Camus, near Chamb and Loch Ericht, in the parish of Laggan; (3) at the northeast end of Loch Cuaich, in Kingussie and Insh; (4) on the Bruar water, near Bruar Lodge, in Blair-Atholl; (5) near the main road from Blair-Atholl to Dalnacardoch.

A significant and hopeful fact in connection with the new project is that the Duke of Atholl and Sir John Ramsden, whose lands are principally involved, are warm supporters of it.

The Severn Valley Tidal Power Scheme

Considerable interest was aroused, especially in the Midlands, during the last year, by publication of the details of a scheme prepared by the Ministry of Transport, for development of power from the River Severn, as

FIG. 3. NEW DAM, CLWYD LAKE

this was the first time that a proposal had been seriously made and discussed, for developing power in England from the tides. If it should prove possible to harness the River Severn in this way for the generation of electric power on an economic basis, there is no doubt that many other similar schemes of tidal-power development in the river estuaries around the British Isles would be found practicable.

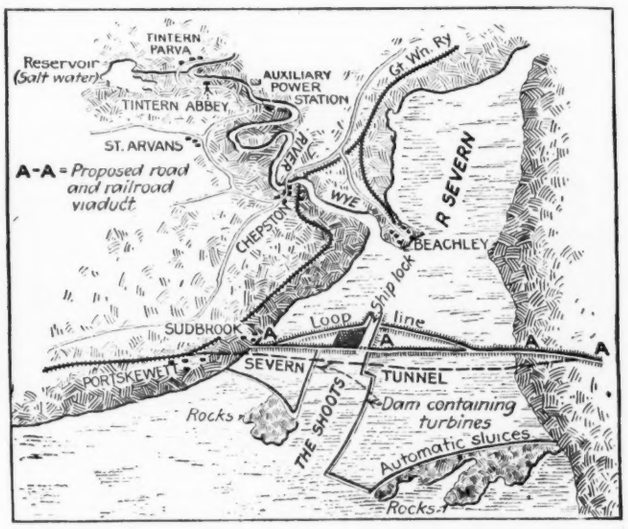


FIG. 4. PROPOSED SEVERN RIVER DEVELOPMENT

The proposals of the Ministry of Transport, briefly, were to build a dam across the River Severn at the point shown in the accompanying sketch map (Fig. 4). One half of this dam was to be provided with automatic sluices, admitting the water to the upper reaches of the river when the tide was rising; and the other half

was to be equipped with turbines and generators that would make use of the impounded water when the tide turned and the ebb flow began. The head of water obtainable by this scheme would vary from five feet to a maximum of thirty feet at spring-tides, and the period over which power would be obtainable would be seven hours out of every twelve.

The turbines to be installed were to be of the vertical-axis mixed-flow type, with a speed of from 40 to 50 r.p.m., while dynamos of 1,300 kw. capacity would be driven by means of helical gearing, to operate at 525 volts.

A high-level reservoir situated above Tintern Abbey would be required for storage purposes. Water would be pumped into this reservoir during the periods when the turbines were producing more energy than required by regular consumers. Therefore a second generating station would be required in connection with this reservoir, the turbo-generators of which would be run during the periods when the tidal generators were stopped.

Industrial Power in the South

Survey of Power Load of Nine Primary Industries Shows Marked Growth During Recent Years

IN 1914 the connected industrial load of the central generating stations of the South Atlantic and South Central States, exclusive of the lighting load, was only 572,900 hp. In the five succeeding years this load increased 221 per cent, or to 1,264,700 hp. The increase in the electrical energy sold to power customers by the central generating stations during this period was even more marked, increasing from 644,900,000 kw.-hr. in 1914 to 2,840,900,000 kw.-hr. in 1919, or 341 per cent. No statistics are available as to the increase in the operation of private generating plants in the Southern States during the same period.

Questionnaires Were Sent to Industrial Plant Owners

In making the survey of the industrial power of the Southern States about 8,500 questionnaires were sent out to industrial plants and 2,824 replies, or 33 per cent, were received, of which 1,068 reported the use of electrical energy as the main source of power. The details of the results obtained from the survey are given in Tables I and II. Probably one of the most interesting portions of that tabulation is the section showing the source of electrical energy used by the companies reporting. The 1,068 plants using electrical energy reported private generators totaling 182,800 hp., which produced a total of 327,965,700 kw.-hr. during 1919. The electrical energy purchased by the plants reporting was only 478,450,627 kw.-hr. It should be pointed out in this connection that about 56 per cent of the industries generating all or a portion of their own electrical energy replied to the questionnaire sent out, while reports were received from only 32 per cent of the industries which purchased their electrical energy. While the figures are incomplete so far as total power is concerned, they are representative, and present interesting comparative results as well as showing practices and tendencies in that section of the country.

Application of Electrical Energy to the Primary Industries

There are nine primary industries in the South, as follows: Food and kindred products, this classification including beverages; textiles; iron and steel and their products, under which are also included railroad repair shops and steel shipbuilding; lumber and its manufactures; paper and printing; chemicals and allied products; stone, clay and glass; metals and metal products other than iron or steel, including mining, and tobacco manufactures. Other less important industries, such as leather and its finished products and vehicles for land transportation, have been included under miscellaneous industries.

Probably the leader of the primary industries of the South is lumber production and the products of lumber. Every state reported extensive use of electrical service in the mills of this industry. The amount of electrical energy consumed annually by the lumber industry of the Southern States is estimated at almost 180,000,000 kw.-hr., of which about 58 per cent is generated in private generating plants. The generation of a large proportion of electrical energy by the private generating plants of the lumber companies is almost universal. This is to be expected on account of their isolation and the accumulation of waste that is used as fuel for boilers.

Careful study has been given in recent years to the possible application of electrical energy to virtually every branch of the lumber industry, and not only is almost every new mill now erected being electrified throughout, but also in many mills steam-driven line-shafts are slowly giving way to electric drives for many operations. Both squirrel-cage and wound-rotor alternating-current motors are used in the lumber industry, the voltage varying from 220 to 550, with a few 2,200-volt motor installations. It is estimated that 7,290 motors, with a total rating of 100,194 hp., are now in use by the lumber industry of the South; of which 1,588 are under five horsepower. About 72 per cent of the machines are belt-driven, 25 per cent are directly connected and only 3 per cent are chain-driven.

The Textile Industry Is the Largest User of Electrical Service

The textile industry is by far the largest user of electrical service among the industries of the South. It is estimated that this industry consumed about 796,450,000 kw.-hr. of electrical energy in 1919, of which about one-fifth was generated in private plants. The large amount of energy generated in private plants appears to be the result of inability to obtain central-station energy owing to the isolation of the mill or the operation of an existing power plant for a part of the energy used and the purchase of the additional amount required. Very few textile mills are now installing their own generating plants if they are within reach of central generating-station service.

About 90 per cent of the motors now installed in this industry are of the squirrel-cage type. The voltage used varies over wide ranges, including 110, 220, 250,

440, 550, 600 and 2,200 volts. The size of the largest motor in textile mills varies from 1 hp. to 250 hp. with the smallest ranging from $\frac{1}{10}$ hp. to 3 hp. It is estimated that 64,000 motors are installed in the textile mills of the South, with a total rating of about 463,000 hp., and that 48,000, or more than three-fourths of these motors, are under 5 hp. About 58 per cent of the machines are directly connected, 31 per cent are belt-driven and 11 per cent are chain-driven.

Every Southern state reports extensive electrical operation in the chemical industry and its allied products. It is estimated that this industry consumed 139,148,000 kw.-hr. in 1919, of which 34,558,000 kw.-hr. or 24 per cent, was generated in private plants. This industry includes the making of dyes, potash, phosphates, gunpowder and all its derivatives, nitrates, chlorine, soda-alkali products, acids and drugs and extracts of all kinds. The squirrel-cage motor is in general use in the chemical industry, with tne wound-rotor motor used for variable-speed operation.

The dust and fumes common to chemical plants often have an injurious effect on motor windings, and for that reason especially protected windings are often required for the motors used in this industry. The esti-

TABLE I—PRIME MOVERS IN THE INDUSTRIAL PLANTS OF THE SOUTHERN STATES

State and Industry	Companies Reporting		Waterwheels,		Internal Combustion Engines		Steam Engines		Steam Turbines	
	Total Number	Number Using Electrical Energy	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.	Number	Rating, Hp.
Virginia and North Carolina:										
Chemicals and allied products	67	38	1	600	1	70	23	4,045	0	0
Textiles	231	141	110	12,036	1	85	38	13,809	16	27,417
Iron and steel and products	60	46	1	250	0	0	13	1,807	1	260
Lumber and its products	94	27	0	0	0	0	34	8,130	2	2,500
Paper and printing	15	10	1	300	2	250	3	675	0	0
Food and kindred products	128	64	4	86	1	300	19	638	1	100
Stone, clay and glass	33	26	0	0	0	0	16	5,390	3	2,450
Tobacco manufactures	10	6	0	0	0	0	10	1,825	0	0
Metal and metal products other than iron and steel	17	10	0	0	8	893	5	450	1	600
Miscellaneous	200	30	0	0	0	0	25	4,260	1	167
Totals for Virginia and North Carolina	855	398	117	13,272	13	1,598	186	41,029	25	33,494
South Carolina and Georgia:										
Chemicals and allied products	204	51	2	250	0	0	17	3,145	7	3,000
Food and kindred products	140	31	0	0	3	23	19	2,200	0	0
Iron and steel and products	64	37	5	1,400	5	70	12	1,918	5	3,450
Lumber and its products	76	15	0	0	0	0	16	2,775	3	3,750
Metal and metal products other than iron and steel	7	5	0	0	0	0	1	225	0	0
Paper and printing	4	3	3	300	0	0	3	1,150	0	0
Stone, clay and glass	33	14	0	0	0	0	4	2,500	0	0
Textiles	202	110	56	26,629	0	0	65	39,245	19	11,340
Tobacco manufactures	0	0	0	0	0	0	0	0	0	0
Miscellaneous	218	5	0	0	2	150	1	100	0	0
Totals for South Carolina and Georgia	948	271	66	28,579	10	243	138	53,258	34	21,540
Florida and Alabama:										
Chemicals and allied products	63	25	0	0	2	200	17	3,100	0	0
Food and kindred products	37	16	0	0	0	0	5	441	0	0
Iron and steel and products	46	27	0	0	0	0	17	6,185	1	300
Lumber and its products	82	14	0	0	0	0	14	1,950	1	1,000
Metal and metal products other than iron and steel	34	14	0	0	0	0	5	830	3	500
Paper and printing	4	2	0	0	0	0	0	0	0	0
Stone, clay and glass	17	9	0	0	0	0	7	170	0	0
Textiles	48	29	20	7,350	0	0	13	12,415	8	7,466
Tobacco manufactures	0	0	0	0	0	0	0	0	0	0
Miscellaneous	4	3	0	0	0	0	0	0	4	972
Totals for Florida and Alabama	335	139	20	7,350	2	200	78	25,091	17	10,238
Mississippi and Louisiana:										
Chemicals and allied products	58	6	0	0	5	4,200	16	2,341	1	1,250
Food and kindred products	54	11	0	0	0	0	33	8,770	6	9,225
Iron and steel and products	16	5	0	0	0	0	6	540	0	0
Lumber and its products	146	29	0	0	12	84	81	14,588	6	5,700
Metal and metal products other than iron and steel	5	2	0	0	0	0	3	675	0	0
Paper and printing	5	3	0	0	0	0	2	125	0	0
Stone, clay and glass	0	0	0	0	0	0	0	0	0	0
Textiles	26	9	0	0	0	0	0	0	0	0
Tobacco manufactures	2	2	0	0	0	0	1	45	0	0
Miscellaneous	18	0	0	0	0	0	0	0	0	0
Totals for Mississippi and Louisiana	330	67	0	0	17	4,284	142	27,084	13	16,175
Tennessee and Kentucky:										
Chemicals and allied products	25	15	0	0	0	0	26	4,412	10	2,405
Food and kindred products	43	27	3	86	1	25	38	3,146	0	0
Iron and steel and products	65	41	0	0	0	0	73	11,885	6	5,093
Lumber and its products	65	12	0	0	0	0	9	1,478	0	0
Metal and metal products other than iron and steel	27	18	0	0	4	30	47	7,665	8	11,183
Paper and printing	0	0	0	0	0	0	0	0	0	0
Stone, clay and glass	11	4	0	0	4	250	4	1,650	3	2,802
Textiles	73	59	5	540	0	0	36	9,438	0	0
Tobacco manufactures	7	3	0	0	0	0	2	400	0	0
Miscellaneous	40	14	0	0	0	0	25	4,710	1	60
Totals for Tennesse and Kentucky	356	193	8	626	9	305	260	44,784	28	21,543
Totals for the ten Southern States:										
Chemicals and allied products	417	135	3	850	8	4 470	99	17,043	18	6,655
Food and kindred products	402	149	7	172	5	348	114	15,195	7	9,325
Iron and steel and products	251	156	6	1,650	5	70	121	22,335	13	9,103
Lumber and its products	463	97	0	0	12	84	154	28,921	12	12,950
Metal and metal products other than iron and steel	90	49	0	0	12	923	61	9,845	12	12,283
Paper and printing	28	18	4	600	2	250	8	1,950	0	0
Stone, clay and glass	94	53	0	0	4	250	31	9,710	6	5,252
Textiles	580	348	191	46,555	1	85	152	74,907	43	46,223
Tobacco manufactures	19	11	0	0	0	0	13	2,270	0	0
Miscellaneous	480	52	0	0	2	150	51	9,070	6	1,199
Totals	2,824	1,068	211	49,827	51	6,630	804	191,246	117	103,890

TABLE II—SEGREGATION OF THE INDUSTRIAL LOAD IN THE SOUTHERN STATES

These data are compiled from an industrial survey being conducted by the McGraw-Hill Company, Inc., under the supervision of POWER and *Electrical World*, and cover plants in all industries employing over fifty operatives.

State and Industry	Summary of Returns Received in Industrial Survey of the Use of Electrical Energy in Southern Industries														Estimate of the Use of Electrical Energy in Southern Industries (Based on Survey and Census Data)								
	Companies Reporting		Electric Generators				Electrical Energy		Motors Installed			Distribution of Drives			Electrical Energy		Motors Installed			Distribution of Drives		
			Direct-Current		Alternating-Current																	
	Total Number	Number Using Electrical Energy	Number	Total Rating, Hp.	Number	Total Rating, Hp.	Generated Kw.-Hr.	Purchased Kw.-Hr.	Number	Total Rating, Hp.	Number Under 5-Hp.	Belt	Chain	Direct or Geared	Generated Kw.-Hr.	Purchased Kw.-Hr.	Number	Total Rating, Hp.	Number Under 5-Hp.	Belt	Chain	Direct or Geared
Virginia and North Carolina:																						
Chemicals and allied products	67	38	12	1,387	1	550	1,546,300	6,476,265	413	8,807	163	280	8	125	2,543,000	22,300,000	1,200	27,590	473	812	16	372
Food and kindred products	128	64	3	33	3	78	164,207	2,899,605	241	4,136	142	146	20	75	740,000	19,730,000	1,610	27,670	948	975	134	501
Iron and steel, and their products	60	46	13	4,086	1	25	5,768,424	36,419,633	2,777	58,036	321	1,655	44	1,078	7,000,000	37,850,000	2,960	61,830	342	1,764	48	1,148
Lumber and its products	94	27	12	1,240	6	5,015	35,545,400	8,745,220	429	13,266	54	306	13	110	40,000,000	54,500,000	930	28,430	117	662	30	238
Metals and metal products other than iron and steel	17	10	2	350	1	750	3,050,000	30,112,900	543	50,271	66	142	7	394	3,675,000	45,700,000	810	75,000	99	212	11	587
Paper and printing	15	10	7	385	0	0	4,560	864,754	109	1,698	77	101	1	7	2,795,000	4,640,000	910	14,140	642	843	9	58
Stone, clay and glass	33	26	8	364	3	1,600	7,348,620	1,435,589	164	6,856	34	83	3	78	9,000,000	9,110,000	340	14,140	71	172	6	162
Textiles	231	141	20	3,083	50	14,797	31,808,773	64,831,879	17,259	90,451	14,985	4,690	1,569	11,000	40,000,000	234,000,000	49,100	256,600	42,600	13,320	4,480	31,300
Tobacco manufactures	10	6	3	230	5	950	1,977,000	747,000	154	1,663	16	84	31	39	7,750,000	3,160,000	620	6,660	65	338	125	157
Miscellaneous	200	30	7	1,250	4	900	1,582,500	1,468,969	280	3,473	124	226	3	51	25,100,000	31,950,000	5,230	64,890	2,315	4,225	52	953
Totals for Virginia and North Carolina	855	398	87	12 408	74	24,665	88,795,784	154,001,814	22,369	238,657	15,982	7,713	1,699	12,957	138,603,000	462,940,000	63,710	576,950	47,672	23,323	4,911	35,476
South Carolina and Georgia																						
Chemicals and allied products	204	51	13	201	7	1,800	5,276,000	20,180,740	638	22,354	137	499	16	123	5,500,000	36,400,000	1,040	36,480	223	812	28	200
Food and kindred products	140	31	4	455	0	0	1,697,700	5,884,800	241	1,521	110	188	12	41	1,750,000	17,430,000	1,300	8,210	592	1,012	77	211
Iron and steel, and their products	64	37	15	15,606	6	3,702	8,768,900	6,952,351	826	21,709	206	414	15	397	13,980,000	11,270,000	1,330	34,880	332	665	27	638
Lumber and its products	76	15	2	464	5	2,117	441,000	1,508,160	208	4,772	30	167	0	41	2,068,000	2,020,000	440	10,010	63	353	0	87
Metals and metal products other than iron and steel	7	5	0	0	1	168	1,834,000	946,000	44	1,035	8	41	2	1	2,000,000	19,220,000	180	4,170	33	168	8	4
Paper and printing	4	3	0	0	2	800	2,000,000	5,250,000	60	3,447	5	45	0	15	2,465,000	8,280,000	90	5,120	8	68	0	22
Stone, clay and glass	33	14	1	75	4	1,625	7,528,250	844,718	114	4,506	21	102	0	11	6,000,000	12,000,000	250	9,680	46	224	....	26
Textiles	202	110	27	1,753	41	24,190	69,319,817	109,776,169	4,551	76,454	1,492	2,234	963	1,354	89,800,000	261,000,000	8,350	140,530	2,736	4,100	1,768	2,482
Tobacco manufactures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,800	1	5	0	1	0	0
Miscellaneous	218	5	1	75	2	150	46,000	269,820	55	857	18	47	5	4	1,634,000	4,310,000	1,030	16,130	336	879	80	71
Totals for South Carolina and Georgia	948	271	63	18,629	68	34,552	96,911,667	151,612,958	6,737	136,655	2,027	3,737	1,013	1,987	123,197,000	371,936,800	14,011	265,215	4,369	8,282	1,988	3,741
Florida and Alabama:																						
Chemicals and allied products	63	25	8	421	7	1,363	1,575,250	2,413,358	159	5,542	75	125	8	26	1,820,000	16,550,000	730	25,440	344	575	46	109
Food and kindred products	37	16	0	0	0	0	0	2,189,100	133	1,745	85	81	5	47	1,670,000	23,750,000	1,540	20,250	984	938	59	543
Iron and steel, and their products	46	27	11	3,950	2	185	10,193,000	25,840,468	876	29,740	248	370	13	493	20,500,000	88,750,000	2,350	80,010	667	996	24	1,330
Lumber and its products	82	14	6	250	3	2,155	931,000	406,530	143	2,790	23	71	3	69	2,053,000	5,670,000	830	16,110	133	412	17	401
Metals and metal products other than iron and steel	34	14	4	280	5	7,850	3,489,000	5,662,000	335	10,474	151	114	25	196	4,000,000	21,320,000	820	25,600	370	279	61	480
Paper and printing	4	2	0	0	0	0	0	63,000	12	25	10	9	0	3	4,000	9,280,000	650	16,490	314	488	0	162
Stone, clay and glass	17	9	1	7	0	0	6,000	1,583,500	38	1,425	0	28	0	10	4,800,000	32,100,000	880	33,030	132	648	0	232
Textiles	48	29	9	2,520	10	5,605	20,173,360	31,379,435	1,892	16,146	1,310	446	46	1,400	24,310,000	97,400,000	3,990	34,010	2,760	940	100	2,950
Tobacco manufactures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	489,000	30	320	6	18	4	8
Miscellaneous	4	3	3	615	1	180	1,005,000	174,000	42	844	7	33	0	9	29,000,000	101,000,000	7,330	92,960	2,475	5,760	0	1,570
Totals for Florida and Alabama	335	139	42	8,043	28	17,338	37,372,610	69,711,391	3,630	68,731	1,909	1,277	100	2,253	88,157,000	396,309,000	19,150	344,220	8,185	11,054	311	7,785
Mississippi and Louisiana:																						
Chemicals and allied products	58	6	7	288	12	4,320	18,600,000	145,300	111	6,023	32	25	3	80	23,330,000	23,800,000	290	15,470	84	65	16	209
Food and kindred products	54	11	17	381	9	2,357	18,423,040	553,121	728	20,836	158	469	29	230	21,130,000	7,380,000	1,090	31,300	236	702	44	344
Iron and steel and their products	16	5	4	393	0	0	1,311,200	1,325,000	320	4,682	125	208	7	105	1,432,000	2,560,000	480	7,106	191	318	11	161
Lumber and its products	146	29	17	1,335	14	5,764	16,173,030	1,307,967	584	7,579	136	376	9	199	56,900,000	8,200,000	2,170	28,230	505	1,397	33	740
Metals and metal products other than iron and steel	5	2	3	375	0	0	216,000	18,000	75	541	3	74	0	1	221,000	268,000	160	1,129	6	158	0	2
Paper and printing	5	3	0	0	0	0	0	474,700	40	437	15	39	0	1	3,000	3,630,000	310	3,353	116	302	....	8
Stone, clay and glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45,000	663,000	12	519	2	8	1	3
Textiles	26	9	0	0	3	500	3,200,000	8,769,000	148	3,548	35	106	4	38	6,180,000	9,220,000	191	4,578	45	137	5	49
Tobacco manufactures	2	2	1	76	0	0	3,300	10,400	11	37	8	4	3	4	3,300	10,400	11	37	8	4	3	4
Miscellaneous	18	0	0	0	0	0	0	0	0	0	0	0	0	0	8,930,000	10,720,000	1,630	20,605	550	1,204	188	238
Totals for Mississippi and Louisiana	330	67	49	2,848	38	12,941	57,926,570	12,603,488	2,017	43,683	512	1,301	55	658	118,174,300	66,451,400	6,354	112,327	1,743	4,295	301	1,758

Tennessee and Kentucky:																													
Chemicals and allied products	25	15	22	1,125	5	1,364	1,862,100	2,603,318	205	5,441	52	132	5	68	1,395,000	5,510,000	320	8,397	81	206	8	106
Food and kindred products	43	27	16	1,774	3	280	843,550	3,576,595	524	3,393	236	324	24	186	2,980,000	17,465,000	2,420	15,659	1,090	1,495	67	858
Iron and steel, and their products	65	41	36	7,010	9	18,251	10,313,973	22,150,006	1,982	25,444	406	870	37	1,075	20,250,000	30,400,000	3,090	39,748	633	1,355	60	1,675
Lumber and its products	65	12	4	600	3	135	263,200	416,585	277	1,653	73	228	15	34	2,525,000	4,620,000	2,920	17,414	770	2,400	162	358
Metals and metal products other than iron and steel	27	18	16	2,977	9	8,750	23,447,407	41,440,300	1,300	40,250	225	480	3	817	37,200,000	92,622,000	2,600	80,600	450	960	6	1,634
Paper and printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57,000	6,980,000	543	13,771	265	477	2	64
Stone, clay and glass	11	4	4	3,250	2	300	5,459,740	1,195,260	129	5,770	12	115	0	14	2,100,000	7,670,000	190	8,468	18	170	0	20
Textiles	73	59	10	801	15	2,059	1,512,632	17,281,395	1,272	14,428	353	720	402	150	2,940,000	33,600,000	2,480	28,180	688	1,401	787	292
Tobacco manufactures	7	3	0	0	1	150	364,100	120,130	51	438	16	38	0	13	632,000	923,000	160	1,408	50	119	0	41
Miscellaneous	40	14	13	2,150	5	400	2,892,367	1,737,387	382	4,441	107	255	80	47	23,450,000	49,000,000	6,000	69,751	1,682	4,000	1,262	738
Totals for Tennessee and Kentucky	356	193	121	19,687	52	31,689	46,959,069	90,520,976	6,122	101,256	1,480	3,162	566	2,404	93,529,000	248,810,000	20,723	283,396	5,725	12,583	2,354	5,786
Totals for the Ten Southern States:																						
Chemicals and allied products	417	135	62	3,422	32	9,397	28,859,650	31,818,981	1,526	48,167	459	1,061	40	422	34,588,000	104,560,000	3,580	113,327	1,205	2,470	114	996
Food and kindred products	402	149	40	2,643	15	2,715	21,128,497	15,103,221	1,867	31,631	731	1,208	90	579	28,270,000	85,775,000	7,900	103,089	3,850	5,122	381	2,457
Iron and steel, and their products	251	156	79	31,045	18	22,163	36,355,497	92,687,458	6,781	139,611	1,306	3,517	116	3,148	63,162,000	170,830,000	8,200	223,574	2,165	5,098	170	4,952
Lumber and its products	463	97	41	3,889	31	15,186	53,353,630	12,384,462	1,641	30,060	316	1,148	40	453	103,546,000	75,010,000	7,290	100,194	1,588	5,224	242	1,824
Metals and metal products other than iron and steel	90	49	25	3,982	16	17,518	32,036,407	78,179,200	2,297	102,571	453	851	37	1,409	37,200,000	179,130,000	4,570	186,499	958	1,777	86	2,707
Paper and printing	28	18	7	385	2	800	2,004,560	6,652,454	221	5,607	107	194	1	26	5,324,000	32,810,000	2,503	52,874	1,343	2,178	11	314
Stone, clay and glass	94	53	14	3,696	9	3,525	5,099,067	20,342,610	445	18,557	67	328	3	113	21,945,000	61,543,000	1,672	65,837	269	1,222	125	443
Textiles	580	348	66	8,157	119	47,151	126,014,582	232,038,078	25,122	201,027	18,175	8,196	2,984	13,942	161,230,000	635,220,000	64,111	463,898	48,829	19,898	7,140	37,073
Tobacco manufactures	19	11	4	306	6	1,100	2,344,400	877,530	216	2,138	40	126	34	56	8,385,300	45,892,000	822	8,430	129	480	132	210
Miscellaneous	480	52	24	4,090	12	1,630	5,525,867	3,650,176	759	9,615	256	561	88	111	88,114,000	196,980,000	21,220	264,336	7,358	16,068	1,582	3,570
TOTALS	2,824	1,068	362	81,615	260	121,185	327,965,700	478,450,627	40,875	588,984	21,910	17,190	3,433	20,259	561,660,300	1,546,447,200	123,948	1,582,108	67,694	59,537	9,865	54,546

mated number of motors in use in the chemical industry of the Southern States is 3,500, with a total rating of 113,377 hp. About 69 per cent of the machinery in use is belt-driven, 28 per cent is directly connected and only 3 per cent is chain-driven.

Metals and metal products other than iron and steel, which subdivision also includes mining of all kinds, are of large importance in certain of the Southern States, especially in Tennessee, Kentucky, Virginia and Florida. The motors used in the mining industry are as a rule of large rating, which accounts for the fact that the average rating of the motors reported by it is over 40 hp. and but one-fifth of the motors are under 5 hp. More than 59 per cent of the 4,570 motors used in this industry are directly connected, 39 per cent are belt-driven and 2 per cent are chain-driven.

Gas-Turbine Combustion Chambers

BY GLENN B. WARREN

In the constant-pressure gas-turbine cycle the compressor supplies air and fuel to a combustion chamber or furnace at constant pressure. This mixture burns and thus increases in volume and passes through a nozzle onto the turbine wheel. Although the theoretical efficiency is reduced by the introduction of water to lower the gas temperature, the water-injection machine is much more practical than one without the water.

Inasmuch as the combustion chamber and the expansion nozzle are the most important elements that go to make up the gas turbine, the investigation undertaken by the author was confined to a study of these elements, the experiments being carried out during 1919 at the University of Wisconsin. While four types of combustion chamber were used, only two were at all favorable. The fourth chamber tested is shown in Figs. 1 and 2. Gasoline was used for fuel and was injected through the spray nozzle shown at *K* in Fig. 2. The air was forced under pressure from an air compressor into the chamber through the passage *J*. The base of the chamber was filled with "Hytempite" cement and clay. The entire chamber was jacketed, and the injection water was taken from the jacket through the needle valves *F* and *F'*. Since the water level was kept below the needle valves, steam rather than water entered the chamber.

The gas mixture was initially ignited by a spark plug; after combustion began, the current was cut off from the spark and the combustion proceeded automatically. The temperature within the chamber was measured by the thermocouple *G*, the average temperature being from 2,250 to 2,300 deg. F.

In the early stages of the work it was difficult to secure continuous combustion. This was due to the low pressure under which the fuel was injected into the chamber. Each explosion raised the chamber pressure, which in turn stopped the gas flow, interfering with the combustion. This was remedied by increasing the fuel pressure.

The following readings were taken every two minutes and the averages used in making the efficiency calculations: Reaction of combustion chamber; weight of fuel and water tanks; venturi-meter manometer readings; incoming venturi pressure and air temperature; temperature and pressure in combustion chamber; temperature of injection water; water level in jacket; steam pressure in jacket.

The results of each run were based on an average of the eight readings taken every two minutes over a period of fourteen minutes, as described in the preceding paragraph. The differences between the weights of the water and fuel tanks at the beginning and end of the fourteen-minute periods were taken respectively as the total water and fuel consumed during the run. These were checked against the rate of flow as determined by the readings taken every two minutes.

The air flow was determined from the average of the readings of venturi-meter pressure, temperature and pressure difference at the inlet and throat. The method of calculation and coefficients used are given in a paper by the writer, which was read before the May, 1920, meeting of the American Society of Mechanical Engineers.

The total weight of fluid passing through the nozzle per second was, then, the sum of the air, fuel and water flows. Inasmuch as the reaction of a jet leaving a nozzle is given by the product of its mass per second and its velocity, the reaction registered on the scale is

$$R = MV = \frac{WV}{g} \qquad (1)$$

where R is reaction in pounds; M is mass and equals $\frac{W}{g}$, W is weight in pounds per second, g is 32.2, and V is the velocity of discharge in feet per second when a final equalization of pressure between the issuing jet and the surrounding medium has taken place. From this equation it is, therefore, a simple matter to determine the

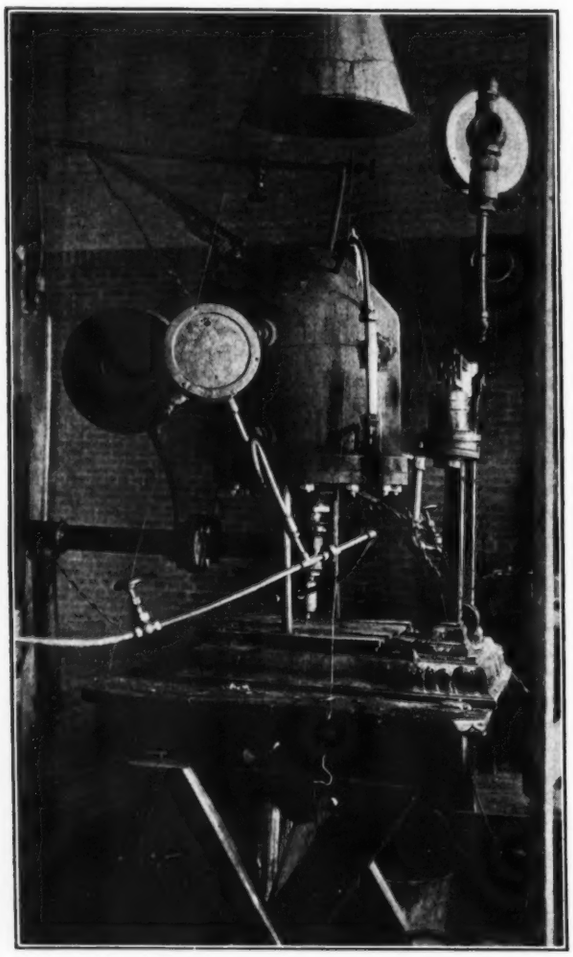


FIG. 1. COMBUSTION CHAMBER READY FOR TESTS

value of the exit velocity when we have determined experimentally the reaction and the weight flow.

Knowing the velocity of the jet, the kinetic energy per pound of products of combustion and water vapor can be determined from the well-known equation,

$$E = \frac{V^2}{2g} \qquad (2)$$

where E is kinetic energy of jet in foot-pounds.

The efficiency ratio of the third combustion chamber and nozzle averaged about 77 per cent, using exact specific heats. The results of five runs with the largest nozzle on the fourth combustion chamber are tabulated in the table. These results averaged about 10 per cent higher than those on the previous combustion chamber.

The writer does not feel that these tests are accurate enough nor was the apparatus perfected enough to be taken as an exact criterion of the efficiencies that might be obtained with a gas-turbine combustion chamber and

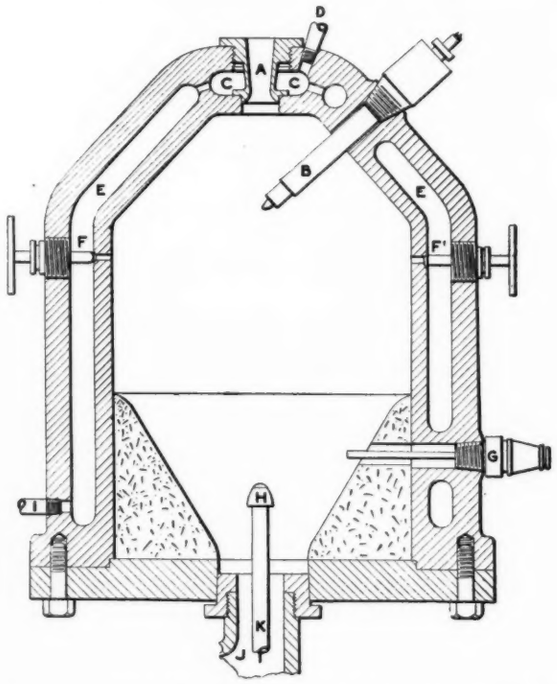


FIG. 2. CROSS-SECTION OF COMBUSTION CHAMBER

nozzle. The tests do indicate, however, that with a combustion chamber and nozzle of proper design a combined efficiency of over 90 per cent should be obtained, and in large sizes it might be possible to exceed this. By efficiency it is meant, of course, that the actual kinetic energy of the jet in any cycle divided by the heat put in will be 90 per cent of what it should be in the theoretical cycle using the same initial temperature and pressure ratio and basing the figures on the exact values of the specific heats as nearly as such can be obtained. This efficiency will, of course, vary somewhat with the total temperature, pressure ratio, fuel used, percentage of water added to the products of combustion, and constructional features of the apparatus.

RESULTS OF TESTS. FOURTH COMBUSTION CHAMBER.

	1	2	3	4	5
1. Run no.					
2. Weight of air per sec. lb.	0.306	0.3118	0.258	0.3107	0.296
3. Weight of fuel per sec. lb.	0.0106	0.01055	0.01533	0.00979	0.01179
4. Weight of water per sec. lb.	0.0369	0.0381	0.0506	0.0292	0.0262
5. Weight of total per sec. lb.	0.35355	0.36045	0.3239	0.34969	0.33399
6. Reaction of jet, lb.	34.56	36.85	38.11	37.15	36.6
7. Velocity of jet, ft., per sec.	3,147	3,290	3,790	3,420	3,480
8. Kinetic energy, B.t.u.	198	216.2	287	233.7	242
9. Initial temperature deg. F.	2,006	1,938	2,072	2,003	1,970
10. Initial temp. deg. F., calculated	1,425	1,535	2,030	1,720	1,885
11. Pressure ratio	7.00	7.55	7.55	7.49	7.35
12. Per cent water injected (4) ÷ (2)	12.05	12.2	19.65	9.4	8.85
13. B.t.u. added per lb.	578	562	909	538	678
14. Ratio of air to fuel	28.7	29.5	16.8	31.7	25.1
Theoretical Conditions and Results of Test (Exact specific heats)					
15. B.t.u. required per lb.	500	536	804	545	618
16. Final temp. after expansion, deg. F.	728	790	1,207	923	1,058
17. Energy available B.t.u.	213.8	230	295.5	246.5	262
18. Theoretical efficiency	42.76	42.9	36.8	45.2	42.4
19. Nozzle efficiency	92.7	94	97.2	94.7	92.3
20. Combustion chamber eff.	86.5	95.5	87.4	101.1	91.2
21. Over-all efficiency	34.3	38.5	31.6	43.4	35.7
22. Efficiency ratio	80.25	89.8	85.8	96.0	84.2

EDITORIALS

Between Two Extremes

IN HIS address, "Personal Observations in the Industry," before the Annual and Pacific Coast Convention of the American Institute of Electrical Engineers, Arthur W. Berresford, president of the Institute, expressed the opinion that he was "not in entire sympathy with what appears to be a growing feeling that the engineer may, with advantage, invade all fields of effort." This statement, coming from an engineer after being for one year president of one of the largest National engineering societies, is worthy of serious reflection. Although in the past the engineer has solved many or made possible the solution of many of the problems of our modern civilization, it does not follow that he is capable of providing, or that it should be his function to provide a remedy for all our difficulties. The war brought the technically trained man to the fore, and before the conflict had progressed very far it was manifest that modern warfare was to a very large degree a chemical and engineering problem. This awakening, combined with the agitation for the engineer to take a more prominent part in public affairs, led to a feeling in certain quarters that the engineer is to be the guiding star in governmental affairs. Nothing probably could carry the engineer so far afield of his proper functions as to try to furnish a panacea for all our governmental ills.

Modern civilization is not propelled by a single element, whether it be law, finance, engineering, economics, industry, hygiene or what not, but by a combination of all these. It is true that many of the most important tasks facing the country today are engineering problems, such as transportation, power development, building of roads, inland waterways, etc., and before they ever will be properly solved they will require the services of the engineer. This does not mean that the engineer alone can supply the proper solution, since they all involve many other questions besides engineering, most of which the average engineer has not shown himself very well suited to contend with. But this does not disqualify the engineer from taking an active part in affairs of public interest, any more than the financier, business man, farmer or others engaged in various pursuits should be disqualified because they may have failed in questions involving engineering.

There are those who point to Watt, Stephenson and others as having won great respect from the public in general by simply devoting their attention to purely engineering problems and refraining from taking any part in public affairs. With the exception of a very few who have done pioneer work of far-reaching effect, engineers have received small recognition for their work from the public. Watt, Stephenson, Fulton and Faraday may be considered as laying the foundation of our present industrial development, which has come to involve engineering to such a large degree. National problems involving engineering had not developed in the days of those pioneers to where they are today. Therefore it is not reasonable to expect that what was proper limitation for engineering practice at the beginning is the scope of engineering today.

Between these two extremes, that of the engineer working in silence and forgetting what is going on around him in public affairs and the position where he attempts to invade all fields of effort, will be found his true relation to the public. Public questions that involve engineering should properly involve the engineer to the degree that this warrants, just as they should involve the lawyer, financier or other interests. But when the engineer attempts to go farther than this, he will find himself caught in a current that he cannot swim against, and will bring down on his head the public condemnation that is being heaped on some public officials who are not engineers by training, but who have the temerity to attempt to solve engineering problems.

More Fog

ONE of the most successful ways to influence legislation in Washington is to involve the issue in a fog of related issues so that there will be a sufficient number of Senators and Representatives opposed to one phase or another of the legislation. This fact is well recognized by the wholesale coal dealers and their worthy legislative representative holding forth in Washington.

Any business man can sympathize and well approve of the wholesalers' objection to having "shackles put upon the coal industry." Least of all does the coal user wish the producer and distributor of this commodity to be in shackles. The user does wish that free, vigorous trade development shall proceed because it is well recognized that only through it can sound principles and methods of coal supply be recognized and practiced. However, the coal user and the industry in general cannot agree with the criticism that the wholesalers persistently raise against the gathering of fundamental information and statistics with reference to the coal business.

One of the late efforts of the wholesalers to befog the issue is a letter to Senator Cummins in which a most pitiful plea is made for encouragement in readjustment to normalcy. The wholesalers ask by what means it is hoped that information will "reduce even by one the number of unnecessary mines, cause the withdrawal from investment in mines of a single dollar, add one day's working time annually to mines that are now idle for lack of demand," and much more irrelevant comment.

It is clear that the wholesalers very much fear that their system of coal distribution will be found improperly organized if all the facts regarding the industry are developed by governmental investigation. The Secretary of Commerce is apparently sincere when he says that he does not believe in the regulation of industry by Government, and with this assurance there can be no valid objection to the continuance of coal

statistical work under the direction of the Geological Survey.

In the end the honest producer and the efficient wholesaler, for there are undoubtedly many of both, will greatly profit by having all the essential facts of the business accurately, promptly and fairly set forth. If there is nothing to conceal, why all this opposition? Public utilities a few years ago went a step farther and gracefully accepted regulation, and the result is now generally conceded as beneficial to all parties concerned. While the coal supply differs technically from the utility in that it is not essentially a monopoly, its service to the public is similar.

Every part of the industry should stop and consider before it again opposes the idea of gathering these facts. Let each consider how much more safely and how much more regularly business could go forward if data could be made available accurately and quickly as to stocks of coal and prices of coal. No one except the profiteer gains from lack of information as to trade conditions. Industry should turn the pitiless light of publicity upon this effort to raise a fog of other issues and insist that Congress be left free to legislate effectively and at an early date upon this subject, for if the obstructors are now successful and next winter should see a repetition of the conditions of the past two winters, the public will probably demand and force drastic measures for regulation of the coal industry that may cause the coal people to wish they had accepted what was reasonable.

Consistent Economy

ANY manufactured article accumulates value as it progresses through the various processes of production. Particular care is therefore exercised to minimize spoilage in the later stages or processes. Electricity may be considered a manufactured product. It is of least value at the generator. Transmission, conversion and distribution expense all enhance the unit cost. It therefore follows that economy is of greatest importance at the point of application of electric power.

It is not uncommon to find much stress laid upon relatively small but justified economies at the power plant, whereas at the point of utilization prodigality often occurs. Electric power is the sole product of the central station. Every effort is bent toward its economical production and distribution. This power is a small item in the cost of most manufactured products, being usually less than five per cent of the total cost. It is probably for this reason that considerable power wastes are frequently permitted without notice.

Among the many ways in which electric power is wasted, the following may be mentioned: Machines running idle unnecessarily, encouraged perhaps by inconvenient control; driven machinery improperly adjusted, causing excess load; operation on armature resistance unnecessarily, possibly incorrect speed provision; operation of machinery, such as a pump, for instance, under conditions giving low machine efficiency; incorrect gear ratios on machines which start and stop frequently, causing excessive resistance losses. There are many opportunities for saving visible to the man who is alert. Although these economies may be small in relation to the total cost of production, they are none the less worth while.

Repairing Electrical Switchboard Instruments

POWER-PLANT operators are usually well aware that when an electrical instrument refuses to indicate and is returned to the manufacturer for repairs, it may take from a week to several months before it is repaired and returned. For this reason it is not uncommon to see a plant limping along with defective or inoperative instruments simply because it takes too long or is too expensive to have them repaired; yet the trouble often arises from a very small defect, such as a little filing in the air gap, a tight jewel or a loose connection.

While it is true that the expert instrument maker must have a delicate sense of touch for fine, accurate work, yet the present trend of instrument manufacture and design is toward more rugged construction. By this construction the instruments may not only be produced more cheaply, but may be repaired by a mechanic who has only ordinary tools and the requisite skill.

There are certain points, however, on which the repairman must be educated, as most of the methods used in repairing motors and lamps will not suffice for instrument work. A striking example of this is soldering; the flux commonly used on an armature is absolutely prohibited in instrument work.

An article in this issue gives a number of points special to instrument repair work. The steps necessary to detect and correct the various most common defects are also outlined. With these instructions as a basis the repairman can undertake the repair of instruments with the feeling that he is not working in the dark, but is proceeding along the proper lines, and that a skillful, neat and accurate job is only a matter of experience.

The Home Furnace and the Coal Market

THE difference between the anthracite industry and the bituminous industry is so clear to those directly concerned with the buying or the burning of bituminous coal under boilers that they often do not realize the attitude of "the man on the street," to whom coal means nothing but coal. The man who buys coal to heat his home, and swears at the price, is at a loss to understand why it is no cheaper when he reads in the daily papers that "the bottom has fallen out of the bituminous-coal market."

This situation is given considerable attention in a letter recently made public from Dr. George Otis Smith, director of the Geological Survey, to Senator Edge. Dr. Smith points out that "bituminous coal is bought by a relatively small number of people; except for the tithe of the output which is handled by retailers, the great bulk of the bituminous supply is purchased by the agents of about 55,000 corporations. In other words, eighty-five per cent of the soft coal is bought by less than one-twentieth of one per cent of the population."

Inasmuch as the soft-coal mines in the United States, according to Dr. Smith, produce in a day as much as the anthracite mines in a week, it may readily be seen that the public as a whole confuses the issue when it bases its estimate of the coal business as a whole upon its contact with the anthracite industry.

CORRESPONDENCE

Motors for Driving Air Compressors

May 17 issue of *Power* contains an article, by Gordon Fox, on air-compressor motors, in which there is one statement with which I cannot agree, since it differs so widely from the results of our experience with compressor installations.

The author states that the required pull-in torque for synchronous motors driving air compressors is 50 per cent. We regularly sell motors for compressor service which are guaranteed to have from 12 to 15 per cent pull-in torque at the starting voltage and we have no trouble in pulling into step. A pull-in torque of 50 per cent on a slow-speed motor is an unusual performance and in many cases would require the application of full voltage.

QUENTIN GRAHAM, Engineer,
Power Engineering Dept.
Westinghouse Electric and Manufacturing Co.,
East Pittsburgh, Pa.

Economical Heating with Live Steam

In the average plant there are always conditions that are misleading to the engineer and will sometimes cause him to operate uneconomically. In a certain plant three steam lines ran to the open feed-water heater. One was the exhaust steam line from the feed-water pump, one was the exhaust line from the fuel-oil heater, and one was a live-steam line from the boilers.

While the plant was using heavy fuel oil, a great deal of steam was used to heat the oil, and of course the steam that passed through the fuel-oil heater, passed into the feed-water heater. During heavy steam loads, when the oil was not very hot, the furnaces would smoke. The engineer knew, from practice, that when the feed-water was hot, the furnaces quit smoking and the boilers carried the load easily. He gave the hot feed-water credit for this condition, failing to realize that it was the hotter fuel oil which permitted better atomization. Hence, when the plant changed from fuel oil to coal, live steam was continually used to further heat the feed water.

It is impossible to put more steam heat back into a boiler than is taken out of it. Therefore it is impossible to heat feed water with live steam and expect it to carry more heat units back into the boilers. Some of the heat will be lost in radiation from the live-steam line, feed-water heater, pump and feed-water line. If the temperature of the feed water is sufficient to prevent metal strains in the boiler, it will not pay to heat the feed water with live steam.

In heating liquids and rooms by means of steam coils, the average engineer will lose heat by permitting steam to escape with the condensates. Some reason that the more steam passed through a coil the more heat will be given out. The heat of saturated steam depends upon the pressure, hence the hotter a coil is required the higher the pressure required. To make a steam coil give up the most heat possible, close the exhaust valve to the coil until it just carries away the condensates and open the live-steam valve wide. This builds up the pressure in the coil.

To control the heat given up by the coil, then control the steam pressure in the coil by the live-steam valve. Also, adjust the discharge valve until it just carries away the condensates. An engineer can generally tell when a coil is filling with condensates by the difference in heat of the ends of the coil.

There are times also, when an engineer thinks it is necessary to use live steam to aid in the manufacture of distilled water for ice making. This is one of the greatest crimes an engineer can be guilty of. Live steam at high pressure turned into the steam condenser becomes superheated steam, hence a great deal more cooling water is necessary to condense it. The cooling water will become hotter, the ammonia-compressor discharge pressure becomes higher, and more fuel is required to operate the plant. Usually, the average engineer will open the live-steam valve so much that a steam back pressure is thrown on the compressor, and more fuel is again needed, for the same output of the plant.

W. A. DARTER.
Brenham, Tex.

[For the same temperature of steam within a pipe there is more heat given up per square foot per minute with active circulation of the steam than with condensatior of stationary steam. It may be that the reason is because with sluggish circulation there is formation of air pads on the pipe which act like non-conductors of heat, or it may be that with active circulation the particles of water of condensation are dashed against the walls of the pipe, acting like hot shot, which is heated and reheated from contact with the steam near the center of the pipe as well as from contact with steam near the walls. There are many operations, such as heating parts of finishing machines or giving heat direct from the exterior of the pipe to cloth, where it is well known that higher temperature is obtained with active circulation and a little lowering of the steam pressure than where the circulation is no more than results from the removal of the condensate.—Editor.]

What a Few Changes Did

A 150,000-lb. per hour open feed-water metering heater had been operating for several years without producing a chart that was at all comparable to what it should be. All water, consisting of the condensate from two turbines, the water from seven water-backs and the city water connection was piped to one manifold.

The returns from the heating system and the high-pressure traps were connected separately. The only water under float control was the city water, which was controlled by a balanced valve, the lever of which terminated at the pivot and had a solid rod between the valve and float levers. The only adjustment that could be made on this valve was to loosen a setscrew on the float lever and change the lever's position in relation to the float inside the suction chamber. It can easily be seen how difficult it was to set this valve to open at any predetermined level.

The water-back water was controlled by a hand valve which allowed the excess water to flow to the sewer. Owing to the siphon effect on the drop-leg to the sewer all the water-back water would flow to the sewer if this valve was opened wide. The purpose of this connection was to use the returns from the water-backs at all times except when the heater was full, due to more condensate and other returns going in than there was water being drawn out. The city-water valve was supposed to open only when the level in the suction chamber was close to the bottom.

In Fig. 1 *A* shows a typical chart procured while the heater was as originally connected. Two troubles are apparent: First, the city-water float-controlled valve worked very erratically, going from the open to the closed positions, never taking any intermediate position; second, owing to the hand control on the water-back water the heater would fill up to the overflow or flood position as shown five times in twenty-four hours, it being impossible for the attendant to anticipate all of the changes in demand of the feed pump.

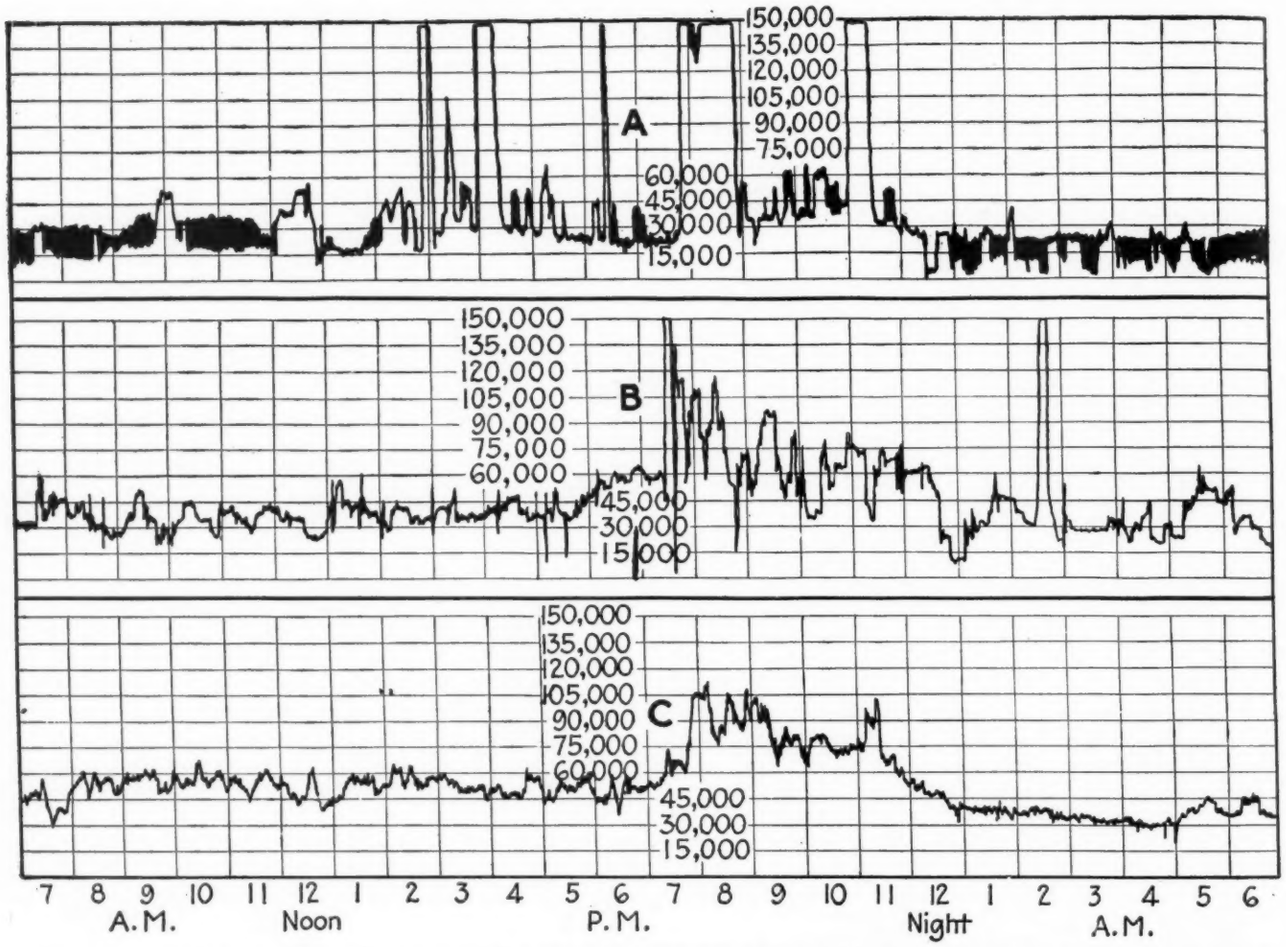


FIG. 1. CHARTS OBTAINED FROM METERING HEATER BEFORE AND AFTER WATER OVERFLOW AND DELIVERY TROUBLES HAD BEEN OVERCOME

Chart *B* shows the first difficulty overcome. The valve lever was extended and a weight placed on the extension, which counterbalanced the rod, thus giving the float much less work to do. Also, a turnbuckle was installed on the rod between the two levers so that the level of the water in the heater can now be very easily adjusted.

The valve is very sensitive, holding the water level practically constant. On chart *B* the sudden changes in flow through the heater are caused by opening or closing the hand control on the water-back overflow. Between 12 noon and 1 p.m. and 5 and 6 p.m. this valve was opened twice. At 7:30 p.m. and 2:30 a.m. the heater filled from too much water not under control.

At the 7:30 overflow the blowoff was opened by the attendant, which practically stopped the flow over the weir for an instant. This must have caused the level in the suction chamber to fall very low, thus opening the city valve wide, which is shown by the immediate jump from 5,000 lb. to 135,000 lb. The effect of this on the feed temperature will have to be imagined as there were no thermometers installed on the heater at that time.

Chart *C* shows the second difficulty overcome and Fig. 2 shows the method employed. An old discarded

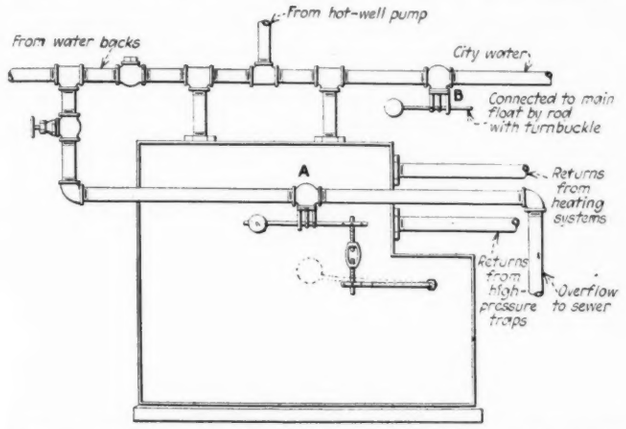


FIG. 2. FLOAT-CONTROLLED VALVE IN CITY WATER AND WATER-BACK PIPES

lever valve *A* was installed in the water-back line discharging to the sewer. This was connected through levers and a tunbuckle to a float inside the suction chamber of the heater. This float was made of three small floats from a type of trap that had been discarded. The lever on this valve is pivoted opposite to that on valve *B* on the city-water line. As the level in the suction chamber falls, valve *A* closes, causing more water-back water to flow into the heater. By means of the turnbuckle the valve is so adjusted that the water-back water is all going into the heater when there is about eighteen inches of water showing in the glass. If the level falls any lower, the city-water valve then opens; therefore it can never happen that water is being wasted to the sewer at the same time that city water is being used. The long drop leg to the sewers insures a full pipe of water when the float valve is opened and discharging water.

By a glance at chart *C* the improvement in feed-water temperatures can be surmised. Unfortunately, there were no recording thermometers installed by which it could be shown. The saving of city water is the one item that can be proved by figures. Since the float valve on the water-back overflow line was installed, the city-water valve has practically never been open. The first month this device was in operation, the city-water meter showed a decrease of 11,000,000 lb. over the same month of the previous year, and with an increase in output. At the prevailing rate this alone was a saving of $77.

But the greatest advantage was the elimination of constant watching, which the old condition demanded from the operating crew, and the impossibility of getting satisfactory results even with the greatest of care. The heater is now self-governing and the trouble is past.

L. P. ALFRED.

Cleveland, Ohio.

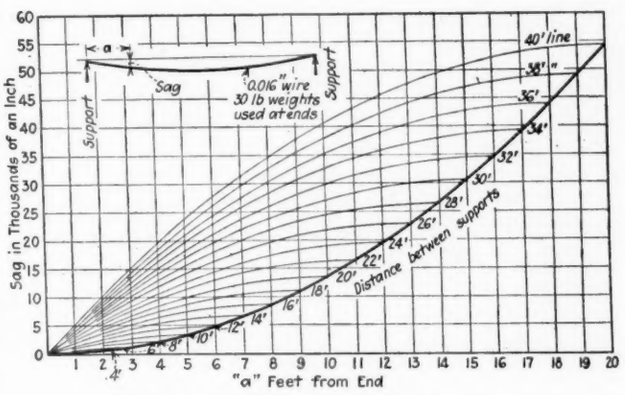
Aligning Engine Shafts

Referring to the letter of Mr. L. Harvey in *Power* for May 3, asking how a unit consisting of two engines with generator and flywheel between them should be aligned: The preferable way would be to remove the crankshafts and generator shafts and align with piano wire stretched through the center line, using pin gages to caliper to the bearing shells. Bearings should, of course, be leveled while aligning. In using a tight wire 40 feet long, as would be required in this case, the sag will be considerable and should be allowed for.

As this method is well known, I assume that Mr. Harvey wishes to avoid the work of dismantling engines and believe he will be able to get good results by a method that I have used under similar conditions.

For this method the two engines and generator should be erected in approximately correct location. Two piano wires should then be stretched, one directly over the center line of the shaft above the top of the cylinders, the other at one side, as near the engine as possible and on a level with the center line of the shaft. To support these wires, horizontal wooden bars should be placed at each end and supported independently of the engines, either on the engine-room wall or by a temporary frame. In either case the supports should be rigid and free from vibration. The tops of the wooden bars are to be rounded and covered with tin plate to permit of moving the wire easily. One of the bars supporting the overhead wire should be so fastened as to permit vertical adjustment. I have found that this can be accomplished very well by clamping to the supporting frame with parallel clamps.

The wire is fastened rigidly beyond one support and tension maintained by a weight of known value suspended at the other end. I have found that a 0.016-in. diameter wire with a 30-lb. weight is a satisfactory



SAG DIAGRAM FOR WIRE LINE

combination. It is best to gage to a journal, if possible, near each end of each shaft, the caps having first been removed.

In Mr. Harvey's case it will probably be best to level the generator shaft first and align the two engines to this. If the shafts happen to be the same diameter at all gaging points, a simple pin gage may be used, allowing for sag with feelers held on the shaft, but as this is seldom the case, a more elaborate arrangement will be needed. This consists of an inside micrometer similar to Starretts No. 124, with a range of 3 to 12 in., a holder for attaching it to a stick, a stick about ⅝ in. square of suitable length, made of light wood, and a

large pin or small finishing nail. With this combination it is possible to gage from the shaft to the line very accurately, using the gage as any pin gage is used.

It should be remembered that any wire will sag, the amount depending on the length. For this reason, in gaging to the line over the shaft center line, the sag of the wire must be taken into account. In the chart the sag in a 0.016-in. wire is given. To use this chart, the curve denoting the length of line between centers is followed until a vertical line through the number of feet the gaging point is from the end support is reached, then reading horizontally the sag in thousandths of an inch is obtained.

Clifton, Ariz. NORMAN G. HARDY,
Chief Mechanical Engineer,
Arizona Copper Co.

Railroad Stationary Engineering

With reference to the article by A. D. Palmer, in *Power*, April 26, under "Railroad Stationary Engineering," and the matter relative to the same subject by J. F. Coen, May 17, I will state that I was for seven years employed in railroad-shop power plant operation by one of the larger railway systems—four years in charge of the power plant at one of their larger shops and three years on the staff of the superintendent of motive power, handling matters pertaining to the operation of several plants on the system.

Having also gone from an industrial plant into a railroad shop, I found it necessary to adjust myself to new conditions as applied to the railroad method of handling power-plant work under the agreements in effect between the railroads and the various crafts, and while there are some objectionable features, I must confess that, after becoming adjusted to the system, I did not find it so very unsatisfactory.

In plants where all the maintenance and repairs are handled by the operating forces, it is necessary to carry a force sufficiently large to handle the maintenance and repairs as well as the actual operation of the plant; in a railroad shop it is only necessary to carry the force actually required in the operation of the plant, and in cases where repairs and other work is necessary, outside help from the shop forces is quickly available without disturbing the operating routine.

At this point I desire to speak a word in defense of the railroad mechanic's ability. While I do not say that they are all good, I have found some mechanics in all lines, as employed in railroad shops, that are as good as can be found in any other lines of industry; in fact, I am personally acquainted with a large number in whom I would have absolute confidence in any kind of power-plant repair work.

As an illustration, we installed a new 300-kw. tandem-compound engine-generator unit at one of the shops. The erecting was done by one of the mechanics out of the shop. In order to enlarge the exhaust header, it was necessary to discontinue the use of the older units while the piping was being changed, and after giving the new unit a half-way trial run, the old units were shut down and the load put on the new unit, and with an overload during the daytime of nearly 30 per cent, the unit ran continuously 24 hours for 8 days without a shutdown and without any trouble. This man was not considered an erector of stationary engines; in fact, that line of work was entirely different from his usual employment.

In considering any system or method of operation, the cost tells the story. While employed in the shop plant mentioned, the local power company made a proposition to the management to sell them power for operating the shops, and the power company had made the matter appear so favorable that the management was very favorably inclined toward the proposition. I was new on the job and had not yet had an opportunity to check our costs very closely. However, I quickly compiled all the available data and presented my figures for consideration. The result was the employment of a firm of engineers to conduct a test and ascertain the cost of producing power in our own plant. The test showed a cost of 0.78c. per kw.-hr. at the switchboard, which was somewhat lower than my estimated figure. The power company did not get the business, but the point is this, I do not consider railroad-shop operating methods so very inefficient, provided the man in charge can adjust himself to conditions as he finds them. Co-operation of the supervisory forces as well as a friendly spirit toward the men themselves is essential to success with the system prevailing in railroad shops. J. C. SNOW.

Hammond, Ind.

Boilermakers as Inspectors

In the May 3 issue, page 714, appears a communication entitled "Boilermakers as Boiler Inspectors." Mr. Palmer's remarks concerning the inability of boilermakers to become good boiler inspectors are both timely and correct—timely, because of the movement on foot in several states to prevent any but boilermakers becoming authorized inspectors of boilers, and correct, because it has so often been proved that the boilermaker's knowledge of boiler design, boiler calculations and boiler operation is so meager and the average boilermaker's lack of desire to gain knowledge along these lines so pronounced, that only in rare cases have boilermakers developed into really first-class inspectors of boilers in service.

I cannot, however, agree with him about the weakening of the 72-in. boiler by the placing of rivets in the corners of the inside cover plates of the butt-strap joint. I might agree to a 19-lb. reduction in pressure on the boiler if such a rivet had been placed in the same relative position in each unit pitch of the joint, but to say that the efficiency of the joint had been reduced 10 per cent by the mere placing of a rivet in each corner of the inside cover plate barely warrants discussion.

I am not surprised that Mr. Palmer was unsuccessful in convincing the boilermaker of the correctness of his contention, and I venture to say that if this is an example of the methods he uses in his inspection work, he finds himself constantly in hot water, either with the boiler user, the state authorities or with his employers if he happens to be an insurance inspector.

I am curious to know what reduction in pressure he would consider necessary should a 1½-in. hole be tapped into the shell of the boiler in question, for a water column or other small steam connection. Also, what percentage of efficiency is lost when the palm of a Scully brace is riveted to the shell of a boiler through the inside cover plate, which method of attaching braces is common and quite permissible in most states having boiler rules. J. L. RALEIGH.

New York City.

INQUIRIES OF GENERAL INTEREST

Opening and Closing Blowoff—What is the proper way to blow down a boiler with a blowoff cock next to the boiler and a valve outside? J. L. M.

The operations should be so performed as to guard against lodgment of scale or sediment in the valve. First open the valve wide, and for blowing off, open the cock slowly, and in closing, close the cock before closing the valve.

Torque in Rotary Converters—In checking up the size of the shaft in a synchronous converter, what should be assumed as the value of the torque? A. L.

There is no torque on the shaft of a synchronous converter other than that necessary to overcome the friction in the bearings, and this may be neglected. The reason for this is that the mechanical driving force due to the current input to the machine and the mechanical resisting force due to the current output both act directly on the armature conductors and are not transmitted through the shaft, as is the case in a motor-generator set. The main consideration in determining the proper size of shaft is stiffness to resist the bending stresses between bearings, with particular care to guard against "whipping" and vibration.

Setting Valves of Duplex Pump—What is the method of setting the steam valves of a duplex pump? W. L. F.

Make a mark on each piston rod at the end of its stuffing box when the pistons are moved up to the cylinder heads, first at one end and then the other end of the cylinders. Then make a mark on each piston rod halfway between the first marks and place each rod so its middle mark will be at the end of its stuffing box. The rocker arms then should stand square with the piston rods. Remove the steam-chest cover and place each steam valve centrally over the ports, and adjust the "lost motion" of each valve rod so it will be as much for one side as the other side of each valve. Before replacing the steam-chest cover, move one of the valves to open a steam port so the pump can start when steam is admitted to the steam-chest. To lengthen the stroke in either end of a cylinder increase the lost motion on the same end of its valve, and to shorten the stroke reduce the amount of lost motion.

Advantages of Damper Regulation of Draft.—What is the advantage of regulation of boiler draft by an uptake damper over regulation by adjustment of ashpit doors? C. H.

A damper admits of closer adjustment to the draft requirements and it is readily operated by a damper regulator automatically controlled by the boiler pressure. The disadvantage of draft regulation by the ashpit doors is that when they are wholly or partly closed for reducing the draft, the loss of heat by infiltration of air through walls, cracks and joints of the boiler setting continues to a greater extent than when the ashpit doors are open. When the draft is regulated from the ashpit, with part draft the products of combustion move in narrower channels and are less uniformly distributed over the heating surfaces. With damper regulation the draft is controlled at the final passage of the heated gases so that infiltration of air is less with reduction of the draft, and when operating with part draft the furnace gases are banked and more uniformly brought into contact with the boiler-heating surfaces.

Slip of Joint and Leakage of New Boiler—A new 66-in. return-tubular boiler that was supposed to have been tested to 150 lb. hydrostatic test before leaving the shop showed slip and leakage of a girth seam shortly after it was placed in service under 90 lb. pressure, but after calking the joint it has remained tight. Is the trouble likely to return and does the slip indicate an unsafe condition? L. D.

If the boiler had been constructed with good material and workmanship, further slip or leakage is not likely to occur without considerable increase of pressure or sudden cooling of the boiler. The slip is not necessarily indicative of unsafe condition. After rivets are driven, they shrink upon becoming cool and do not completely fill the rivet holes in the plates, and when the stress on the joint is sufficient to overcome the friction between the plates, there is slippage of one plate over the other until the rivets come to a bearing for resistance of the shearing action of the joint. All slip may not have been taken up by the shop test, and subsequent slippage could occur with less pressure if friction between the plates became reduced by change of form from handling and heating the boiler.

Obtaining Equal Leads on Corliss Engine—In setting the valves of a Corliss engine the wristplate was placed central, the steam valves were given $\frac{1}{4}$-in. lap and the exhaust valves placed line on line. Then the engine was placed on the crank-end center and the eccentric set to obtain $\frac{1}{16}$-in. lead, but upon turning the engine over to the head-end center, the steam valve was found to have $\frac{1}{32}$-in lead and when the engine was run it pounded badly. What was faulty in the valve setting? C. L. H.

The inequality of leads resulted from the reach rod carrying the wristplate farther over to one side than the other side of the central position, because the reach rod or eccentric rod was too long, giving the effect of shortening the steam-valve rod on the crank end, lengthening the steam-valve rod on the head end, and earlier release, later closure and less compression of exhaust on the head end, and the effect of lengthening the exhaust-valve rod on the crank end with later release, earlier closing and more compression of exhaust on that end. Under these conditions pounding of the engine would be likely to result from reduction of the compression on the head end.

Before adjusting the laps of the valves, the eccentric rod length should be adjusted so the rocker will be moved as nearly as possible as much to one side as to the other from a vertical position, and then the reach rod from the rocker to the wristplate should be adjusted to such length that when the engine is turned over the central mark on the wristplate will be carried as much to one side as to the other side of the middle mark on the wristplate stud. If the steam valves are then given the same laps and the exhaust valves set line on line, setting the eccentric to give $\frac{1}{16}$-in. lead on one end will give the same lead on the other end and the compression will be the same for both ends.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Unusual Boiler-Tube Corrosion By Carbon Dioxide

As part of a Symposium on Corrosion held by the American Electrochemical Society at Atlantic City in April, 1921, a paper on "Unusual Boiler-Tube Corrosion" was presented by Barzillai G. Worth[1] which is reproduced herewith, practically in full. Mr. Worth stated that the destruction of feed-water piping and corrosion of boiler tubes by dissolved carbon dioxide is a well-known occurrence, but the following unusual case of boiler-tube corrosion is of interest as showing how unusual feed-water impurities in some localities can accentuate this condition, and require special means to obtain satisfactory feed-water conditions.

The boiler in question is located in New Jersey, has 2,640 sq.ft. heating surface and is of Babcock & Wilcox make, longitudinal-drum type, with cast-iron vertical headers and No. 10-gage hot-finished seamless steel tubes. When first installed, it was fitted with hand-fired grates, but on account of labor conditions was later equipped with a Reagan overfeed stoker, burning run-of-mine bituminous coal under moderate forced draft. The tubes are cleaned by hand-operated lance blowers. The boiler was normally operated at 150 lb. pressure per square inch and 125 deg. F. superheat, supplying steam to a turbo-generator furnishing current for an electrochemical plant, and the load was very uniform. Except for periodical shutdowns, the load was on for 24 hours a day seven days a week.

The feed water for the boiler was taken from a creek which comes down through the Jersey mud hills of this section and is dammed up at the plant to produce a pond, just before it flows into Raritan Bay. This pond has a water level only a few feet above mean high sea-level. In the summer and autumn this water is quite full of vegetable material. Sometimes in the winter a high tide backs up over the weir and floods the reservoir with salt water.

Analysis of the water varies, an average sample being about as follows: Silica and clay, grains per U. S. gallon, 0.373; iron and aluminum oxides, 0.257; sodium chloride, 0.560; calcium sulphate, 1.563; magnesium sulphate, 0.910; organic matter, 0.326; total solids, 3.989; free sulphuric acid, 0.592.

The condensate from the turbine and the condensate from a considerable manufacturing load in the form of heating coils were returned to the boiler. However, there were a number of heating operations that were performed by passing steam directly into the solutions, and a large amount of distilled water was used for factory purposes, so that the makeup amounted to about one-third of the evaporation.

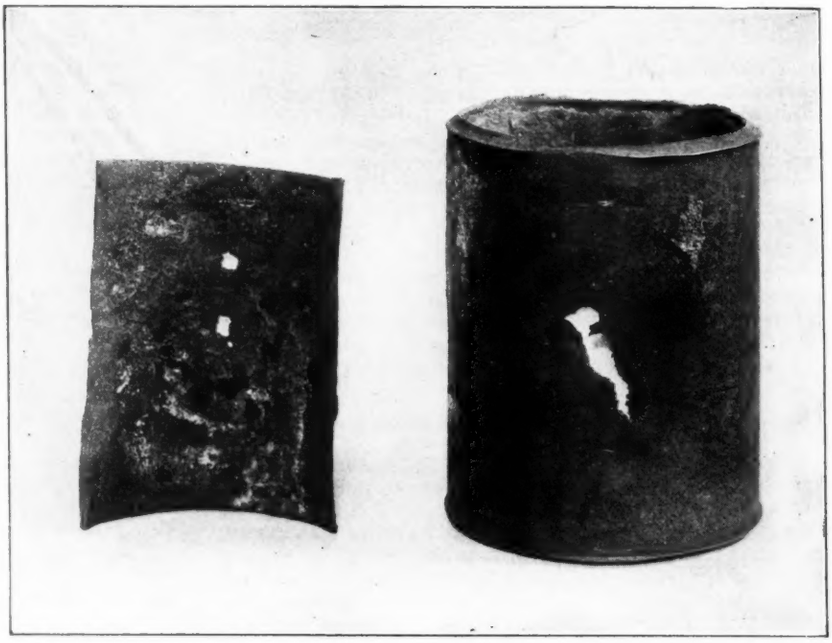
The creek water, before going to the boiler, was treated in a standard lime and soda softener with the usual chemical feed apparatus, sedimentation tank and filter. This softener had a capacity of approximately 8,000 lb. of water per hour, which is ample. The treatment was designed to take care of the scale-forming material and acid. Salt water was handled by salinometer tests and blowing down.

For the first few years, and before installing the stoker, the boiler was operated at about 125 per cent of rating without special difficulty, but after the stoker was put in and the load increased to approximately 175 per cent of rating, with correspondingly increased demands on the water softener, tube failures began to be experienced and soon became serious.

These failures were due to pitting and perforation of the tubes. The pits at first were small hemispherical spots and would break out in tiny holes which could be permitted to go without repair for weeks without seriously affecting operation. But soon they were no longer small holes, but areas of 0.5 to 1.5 in. in diameter corroded down to paper thinness, and then this area would open out and the boiler could not carry load and maintain pressure. The drums were also slightly pitted, the pits being of an irregular shape and very shallow.

In two cases the holes in the tubes were so large that the water ran out as fast as feed pumps could force it in, feed was cold, pressure dropped, pumps had to stop for want of steam, boiler drained out down to the hole in the tube, and in spite of drawn fire the hot setting heated the tubes and racked the boiler to such an extent that every tube in the boiler had to be re-expanded and tightened.

The location of pitting in the drums was almost entirely at or near the rear ends, where the feed water was discharged into the boiler. The pits in the tubes were almost entirely in the lower or rear section, where the relatively cool water was being heated as it came from the downflow header. All the holes were in the tops of the tubes. This



RUPTURED TUBES—LEFT: EARLY PITTING, INSIDE VIEW. RIGHT: HOLE WHICH SHUT DOWN BOILER

pitting was at first assumed to be due to the carbonic-acid gas generated from the vegetable material in the water, and special pains were taken to filter this vegetable matter out and to increase the effectiveness of treatment. In order to get more dependable results, instead of using lime and soda-ash, caustic soda was introduced directly into the water, thus eliminating the lime salts introduced by the lime-soda treatment. This helped somewhat, but the feed-water softness was still insufficient to stop the pitting.

Next the introduction of zinc plates was tried. Two plates were placed in each drum, entirely submerged and carefully connected electrically with ⅞-in. iron rod tapped into plates and into the top of the shell of the drum. The effectiveness of the zinc plates was measured by carefully mapping and measuring the pits in the drum. The pitting of the tubes was inaccessible and so could not be measured. The zinc was quite effective in preventing the further pitting of the drum, but the trouble in the tubes continued to be apparently as bad as ever. At this stage the use of electrolytic protection or cathodizing was carefully considered, this protection having been used very effectively in this plant for the protection of cell parts, etc. But it was considered at the time that since the zinc showed such poor results, it was better not to attempt it.

[1]Vice-president, Walter Kidde & Co., Inc., New York City.

A careful laboratory study of the condition of the water was made by the chemist in charge of the electrochemical plant. This study brought to light a condition previously unnoticed in the feed-water analysis and design of softening system; that is, that one of the important impurities of this water was a soluble bicarbonate of iron, $H_2Fe(CO_3)_2$, characteristic of all the water in this section, well water as well as surface waters. This bicarbonate of iron remains stable at ordinary temperatures, but when heated breaks up rapidly with release of carbonic-acid gas, the precipitate being a ferric hydroxide, which colors red all scale and mud. Although the softening treatment should under ordinary circumstances have taken care of this, a considerable amount of bicarbonate was fed into the boiler in spite of the treatment. This was due to conditions in the creek, where the changing water composition every few hours, due to rains and other conditions, made it impossible to maintain an exact adjustment of the chemical softening treatment, and thus bicarbonate was frequently carried into the boiler.

The consequence was that when the feed water entered the boiler and was heated to high temperature, carbon dioxide was given off in large quantities, and this was probably responsible for the rapid corrosion. Where the feed water entered the drums at the rear ends from the feed line, it was comparatively cool and the corrosive effect small, but where the water entered the tubes from the rear headers and was highly heated and concentrated, the evolution of gas was rapid and the corrosion marked.

Settling Tank Converted Into Hot Treatment System

To rectify this condition, the water-softener settling tank was fitted with heating coils and thus converted into a hot treatment system. Live steam coils were found necessary, and the size of the softener was found to be such that the water would stay in it for about eight hours. Experiments showed that the complete break-up of the bicarbonate takes place in approximately five hours at 80 deg C. So when taken from the softener the water was practically free of soluble bicarbonate. The insoluble compounds were precipitated in the softener tank and blown out with the sludge. The high temperature of the water in the softener, due to the live-steam treatment, boiled out the carbonic-acid gas almost completely, but to eliminate the last traces of carbonic-acid gas left in the water it was arranged to introduce the water into the hotwell through a spray, which gave opportunity for the rest of the gas to escape. Of course this might introduce air into the water, but as between carbonic-acid gas and air the latter was held to be less injurious. Air was almost entirely absent from the hotwell, which was inclosed and vented through a long pipe, and into which hotwell steaming water returned from the coils at boiling temperature and without air. The return from the turbine condenser, being brought back through a separate removal pump, was air free.

Immediately after the introduction of this hot water treatment the trouble with the boiler began to decrease, and in about three months had practically disappeared. Incidentally, the effectiveness of the softener for preventing scale was greatly increased.

The cost of installing this apparatus was very slight in comparison with the savings. The insulating covering of the heater, including the necessary flues for gas discharge, etc., amounted to approximately $350. The high-pressure line and heating coil in the softener amounted to about $100 more.

The heat losses of the softener were estimated at something less than 29,000 B.t.u. per hour, and of course the heat used to raise the water to boiling was not lost, as it was practically all returned to the boiler.

The policy of wide distribution of stock to people in the territory served has been actively resumed by the Southern California Edison Co., following authorization of the Railroad Commission in January for the sale of an additional $10,000,000 par value of its common stock. In four months the total sales reached $6,634,800 par value to 8,823 subscribers, or about $750 each.

Future Power Development in the Middle West*

By C. W. Place

At present the sources of power for the supply of light, heat and energy in the Middle West are coal, oil and gas-fired steam equipment, internal combustion and heat engines, and water-driven equipment. Table I indicates the coal production according to Government estimates. Table II is an extract from the *Electrical World* estimate of the water-power condition of the Middle West, and Table III shows the oil production in 1920, that of the Middle West being 15 per cent of the total production of the United States. From maps showing the location of the coal fields, of the rivers and larger streams and of rail transportation systems, it was made evident that the coal fields were not located conveniently as regards water supply for condensing purposes and not particularly convenient to the load concentrations as at present arranged. On the basis of conditions existing and the present economical production, every 100,000 kw.-hr. produced per day will require 380 million gallons of water, or a flow corresponding to 588 sec.-ft. for condensing purposes. Thus, with some few exceptions, power for the Middle West cannot be taken

TABLE I. GOVERNMENT ESTIMATE BITUMINOUS-COAL PRODUCTION, IN 1,000 TONS

	1917	Per Cent	1918	Per Cent	1919	Per Cent	1920	Per Cent
Total U. S.	551,790	100	579,385	100	458,063	100	556,563	100
Arkansas	2,143	1.0	2,227	1.0	1,680	1.0	2,310	1.0
Illinois	86,199	41.6	89,291	40.0	64,600	38.5	90,050	40.6
Indiana	26,539	12.8	30,678	13.7	20,500	12.2	30,420	13.7
Iowa	8,965	4.3	8,192	3.6	6,300	3.7	9,170	4.1
Kansas	7,185	3.5	7,562	3.4	5,750	3.4	6,700	3.0
Kentucky	27,807	13.5	31,612	14.2	28,500	17.0	31,000	14.0
Michigan	1,374	0.6	1,464	0.6	930	0.5	1,440	0.6
Minnesota	.....	....	.....	....	.....	....	.....	....
Missouri	5,670	2.7	5,667	2.5	4,060	2.4	5,750	2.6
Nebraska	.....	....	.....	....	.....	....	.....	....
North Dakota	790	0.4	719	0.3	750	0.4	770	0.3
Ohio	40,748	19.6	45,812	20.5	35,050	20.8	45,000	20.2
South Dakota	.....	....	.....	....	.....	....	.....	....
Wisconsin	.....	....	.....	....	.....	....	.....	....
Total 14 States	207,520	37.6	223,224	38.6	168,120	36.7	222,610	40

Fourteen states, per cent of total U. S. Per cent opposite each state is per cent of production of 14 States.

care of at the mines owing to the lack of streams of the proper size near the mines. On the other hand, the rivers and streams are in better relation to the load, as the cities and towns have grown up along the streams.

In the past the production of power by steam has been practically always at the load concentration. A start has been made in transmitting from steam stations to less heavy load centers, and a moving of load to cheap power has been successful in a number of cases. But this has caused unnatural conditions in other respects and has not necessarily been for the greatest good of the country as a whole. This territory has no great sources of hydraulic power conveniently available which can be profitably developed at present money rates and material costs, so that it is necessary to lay plans for the conditions as they exist.

Large blocks of power have been developed at centers of load by large steam stations. These large centers, however, are not close together, and each has its tributary country with low load density. This territory is made up of towns and villages surrounded by farming country drained by innumerable streams. Around these streams the author made his plans for the future. They should be developed to supply the necessary power for all the towns and villages near them up to cities of 25,000, and even here during a good part of the year they could assist during the peak if properly connected and manipulated.

In the fourteen Central States there are 102 cities of over 25,000 people. Cities of this size have already established quite efficient steam plants. The first step is to connect the power houses of all these 102 cities, not by heavy high-voltage lines, but by lines which would pick up the small town and village load up to the point where its next large neighbor would take its share. The streams

*Abstract of paper presented before American Society of Mechanical Engineers, Spring meeting, Chicago.

near these towns and villages are to have hydro-electric stations of a size proportionate to the size of the stream. These 102 steam stations must work on a fair load to get their best efficiency both from a steam economy and a maintenance basis, and when the units are operating at good efficiency a sudden increase in load cannot be handled properly until other units are brought on and steam conditions have been restored. During this period of adjustment the voltage goes down and the frequency droops, and would droop more if the voltage were brought back to normal. The present practice is to carry extra machines either under part load or ready to put on at once to meet these conditions.

Suppose the interconnection mentioned previously has now been made, and a goodly number of these hydraulic stations installed, the latter being large enough to take a little more than the average stream flow, in other words, being overdeveloped. Each hydraulic station has a small pondage and is automatically controlled so that it will come on the line on a drop of frequency of the system and in sequence with other plants, depending on the proportion of its working head available at the instant. The plant with the best water conditions will get on the line the quickest. It will drop off the line on a decrease of its water supply or a dropping off of load.

With the steam stations operating efficiently, suppose there is a sudden increase in load. Various hydraulic stations are operating, using up the natural stream flow and sending but a small proportion of their load toward the city. With the droop in frequency the several waterwheel generators installed for the flow above the average begin to come in and to draw on the ponds. Enough come in to bring the frequency back to normal. In the meantime the steam stations are back to normal, the operators have not let the voltage stay down to save the speed, but have restored it at once, and the service has been maintained. With this automatically started reserve there is an opportunity to decide whether the load is going to continue, and if so, to get on extra boilers and machines. It is

TABLE II. WATER POWER IN MIDDLE WEST

(Extract from *Electrical World* estimate, Jan. 1, 1920)

State	Potential Maximum	Developed Hp.	Developed Per Cent of Max.	Undeveloped Maximum	Growth Industrial Hp. Req. in 1930 in Excess of Present Station Rating
Arkansas	75,000	13,400	17.9	61,600	7,000
Illinois	410,000	191,000	46.7	219,900	1,302,000
Indiana	140,000	183,000	130.0	.....	558,000
Iowa	450,000	423,000	94.2	27,000	78,000
Kansas	320,000	105,000	32.8	215,000	7,000
Kentucky	250,000	61,400	24.6	188,600	62,000
Michigan	350,000	357,000	102.0	.....	1,535,000
Minnesota	600,000	233,000	38.8	367,000	261,000
Missouri	200,000	39,500	19.8	160,500	49,000
Nebraska	280,000	65,200	23.3	214,800	.....
North Dakota	150,000	1,000	0.7	149,000	10,000
Ohio	215,000	200,000	93.0	15,000	1,150,000
South Dakota	90,000	11,900	13.2	78,100	.....
Wisconsin	1,150,000	237,000	20.8	913,000	298,000
	4,680,000	2,121,400	.....	2,608,600	5,317,000

known that the hydraulic helpers are going to begin to drop out as they exhaust their pondage, so that steam operation can be governed accordingly.

Now, suppose each of these streams had the low swampy ground and the willow thickets made into ponds even where there is insufficient head for power development, which could release when the ponds with hydro-electric stations were drawn down by this sudden drain and close when the station pond was restored. This would mean perfect flood control for normal rises and, by holding out steam stations, very good control during extreme floods.

These smaller streams lead to the larger rivers and with an approach at flood control on the tributaries there would be a greater number of locations for hydro-electric development on a larger scale along these larger rivers, each to be controlled in the same way. Each development would help the flood conditions below and make feasible developments not now economically practical.

Another suggestion offered, which might be feasible in certain localities, was to pump the water into reservoirs at an elevation during light loads and draw on it to help out during peak loads. The success of this plan depended largely on whether natural pondage was available, as the construction of a pond would create an expense out of all proportion to the service rendered.

A multitude of these small stations would, by means of legitimate interconnections, do more actual work than the same installed capacity in one station. The small station made automatic can usually be installed on a more satisfactory basis than the large installation. It can usually be financed locally so that a good share of the money will remain near the site. A large amount of land will not be

TABLE III. GOVERNMENT ESTIMATE CRUDE-OIL PRODUCTION IN 1920

	1,000-Bbl.	Per Cent Total of 14 States
Total U. S.	443,402	....
Arkansas	.....	....
Illinois	10,772	16.2
Indiana	932	1.3
Iowa	.....	....
Kansas	38,501	58.2
Kentucky	8,679	13.1
Michigan	.....	....
Minnesota	.....	....
Missouri	.....	....
Nebraska	.....	....
North Dakota	.....	....
Ohio	7,412	11.2
South Dakota	.....	....
Wisconsin	.....	....
Total for 14 States	66,296	15

taken out of production, so there will not be a large overhead, and the land that is taken will be of small value. It is, therefore, necessary to multiply the number of stations instead of increasing the size, if it is desired to get the greatest total capacity possible. If the smaller stations are first installed, it would seem that the larger streams could be used if developed on the same general plan, and money made by the development.

There were many things the engineer might do in advancing this or some similar plan. Public opinion could be influenced in the proper direction so as not to obstruct such development. Rivers that were technically navigable but were not really so should either be released or made navigable and the flow used for power development. In the permanent highway-improvement campaign influence should be used to have these permanent highways detour sites for future developments or their natural ponds. The relative importance of railway transportation and power development may change, so that any readjustments of railway roadbeds up river valleys should be along the lines not to interfere with the possible stream development. Existing power sites in the form of mill dams should be developed and tied into the nearest transmission line. The possibilities along this line should be investigated and gotten under way in every locality. The investing public should be instructed along the lines of developments in their vicinity. Water-power possibilities are not gold mines for the owners and of little value if not tied in with existing systems, and when so connected they increase the value of the system and makes its securities a better investment for the public.

Illinois To Combine Navigation and Power Development

The preliminary permit authorized by the Power Commision May 20 for the State of Illinois covers power development at four sites on the Illinois waterway, which is being constructed by the state. The power sites are located at Brandon Road below Joliet, on the Desplaines River; at Dresden Island, in the Illinois River; at Marseilles, on the Illinois River, and at Starved Rock, on the Illinois River.

The State, in undertaking the construction of this inland waterway, is planning to utilize the natural flow of the Desplaines and the Illinois rivers, supplemented by the flow of the drainage canal of the Chicago sanitary district. Locks will be located at the four power sites mentioned. It is the intention to utilize the excess flow above the needs of navigation for the generation of electric power. The permit will specify that it is not to be construed as an authorization for the diversion of water from Lake Michigan.

Heating Engineers Meet at Cleveland

From June 14 to 17 at the Hotel Winton, Cleveland, the American Society of Heating and Ventilating Engineers held its semi-annual meeting. An attendance of 378 for a spring meeting was the largest on record for the society. In the professional sessions the papers were of unusual interest and value, and in the way of entertainment Cleveland exceeded all expectations. Three banquets at one convention, special entertainment following a fifty-mile automobile tour around the city with stops for inspection of interesting plants, were the features, and additional entertainment was provided for the ladies.

At the opening session on Tuesday afternoon F. G. Phegley, president of the Ohio Chapter, welcomed the visiting engineers, President C. L. Riley responded and the business of the meeting was introduced by committee reports. C. V. Haynes, of the Committee on Chapters, gave out the twelve subjects that had been selected for chapter discussion during the coming year and the arrangement by which the discussion on these subjects from the various chapters would all be sent to the secretary to be correlated and combined.

L. A. Harding presented a tentative code for the testing of low-pressure heating systems for residences and small buildings. The heating and piping contractors had solicited a standard method through which their work might be accepted, and in legislation on this subject there was need for uniform guidance. As outlined, the code was to include methods of figuring essential quantities that enter into the performance of a heating system, but it was the consensus of opinion, and so voted, that the design of the system be left to other committees and that efforts be concentrated in formulating a simple and uniform method of testing.

The Committee on Increase in Membership reviewed the standing of the various chapters, giving the increase or decrease in membership and reported a total membership of 1,400. In a progress report the Committee on Model Chimney Ordinance outlined the numerous points requiring research before it was possible to get down to definite standards.

Revision of Constitution

F. R. Still, chairman of the Committee on Revision of Constitution, presented a revised draft in which only essential factors were retained and the remainder transferred to the By-Laws to facilitate the conduct of business. Some slight changes appeared and a new class of membership—intermembers—was introduced, this class having all the requirements and privileges of a member, the age limitations ranging between 25 and 32 years. The report was received and by special request of Mr. Still was recommitted for the consideration of a new chairman.

The Committee on Legislation had been enlarged recently so that there was representation in every state of the Union and it was in a better position to keep in intimate touch and refer anything of importance to the individual chapters on to the national body. Standardization and uniformity of ventilation laws was its primary object, but in effecting this a distinction was drawn between influencing legislation and in having the committee's influence felt.

By the Committee on Memorial to Prof. John R. Allen, the late director of the Research Bureau, a full-size drawing of the bronze tablet to be erected was shown and a request made for a small donation from every member of the society to cover the expense. A partial report of the Committee on Schoolhouse Standards followed, and the time available permitted a report only from the Illinois Chapter, which had increased its membership during the last year from 101 to 131 and at its meetings had had an average attendance of 70.

Wednesday morning was devoted to the Air Conditioning Session, including papers on "Drying of Fruits and Vegetables," by Ray Power, of the U. S. Department of Agriculture; "Drying as an Air Conditioning Problem," by A. W. Lissauer; "Resistance of Materials to the Flow of Air," by A. E. Stacey, Jr. In the second paper a new radiant-heat drier was introduced and results cited to show the superiority of the new method. In the discussion adherents of the moist-air drier were heard from. The relative advantages of the two systems and of convected vs. radiant heat were subjected to detail consideration.

In the third paper the author described the testing equipment he had used in determining the resistance to the flow of air through various materials that might be used as dry filters for the removal of carbon particles from the air, such filters to be used in combination with air washers, as the latter removed only about 50 per cent of the carbon particles; complete results of tests were given, formulas developed to give the resistance loss for various materials and the following conclusions presented: (1) That the resistance of air filters varies directly with the velocity of the air through the material; (2) that the resistance is not affected by variations in relative humidity; (3) that the resistance of cotton felt is approximately 100 per cent greater than wool felt of the same weight.

Doings of the Heating Session

At the Heating Session held on Thursday morning, E. B. Elliott presented an interesting paper on "Byproduct Coke Ovens and Their Relation to Our Fuel Supply," reviewing in an introduction the decreasing reserves of coal, petroleum, natural gas and wood and the possibilities of conserving these fuels. Extension of the byproduct coking process was placed first because of the unlimited possibilities and the byproducts that might be recovered. Attention was given to the construction and operation of coke ovens, coke preparation and yields from one ton of coal, and the possibilities of coke as domestic fuel were presented. Owing to the higher efficiencies possible with coke and the conservation feature, the society went on record as favoring a greater production of coke and its increasing use for domestic heating purposes.

A paper by Harold L. Alt, of Shanghai, China, described a hot-water heating installation in a bank building with no basement, dwelling principally with circulating difficulties encountered. Another paper dealing with circulation problems in hot-water heating had been prepared by A. W. Luck. Among other things it showed how to pass hot-water flow and return mains under a girder and the circulation of water below the level of the boiler.

"Fractional Distribution in Two-Pipe Gravity Steam-Heating Systems" was the subject of a paper by A. A. Adler and J. A. Donnelly. In the method proposed, the rate of steam flow is controlled by a regulator at the boiler to conform with outside temperatures and the steam is distributed to each radiator in proportion to its requirements for any and all loads by a fractional distribution valve with an orifice in each half of the union. By rotating one-half of the union relative to the other, any opening between the minimum and maximum is possible. The general plan is to have a uniform total pressure drop to each radiator to insure uniform distribution, this being effected by adjustment of the orifice. When the adjustment is once made for maximum load, the distribution is evenly effected at all loads. In the discussion objection was made to introduction of friction into the circuit and it was felt that it would take too long to heat up the radiator with restricted steam admission. Favorable comment was made on the individual control of the radiator, as it lessened the work of accurate pipe sizing and uniform length of circuit to obtain circuits of equal resistance.

Application of Gas to Heating Buildings

A paper of Thomson King gave a wealth of interesting information on the application of gas to the heating of residences and commercial buildings, dealing first with the general properties and the conditions affecting the combustion of gas, then with the types of burner and appliances used, with final expression on the future of gas heating and its possibilities.

Ventilation was the subject for the Thursday afternoon session. An extended report on "Ventilation in Metal Mines" was presented by D. Harrington. J. R. McColl made a plea for better air distribution in ventilating systems, with a view to lowering the amount of air supplied and thus reducing the coal bill. Recirculation of a large portion of the air in schools or intermittent ventilation also offered

possibilities for effecting economy. Discussion of the paper brought out the fact that the usual standard of 30 cu.ft. per minute per pupil was not needed so much for purity as to give the flow and movement desirable. One school supplied with 10 cu.ft. of air per pupil had given better results than others supplied with three times the volume of air. It was a question of distribution, and by keeping this factor in mind when laying out the ventilating system, economy could be effected without reverting to recirculation, which, from the hygienic viewpoint, had objections.

A paper on centrifugal-fan design, by F. W. Bailey and A. A. Criqui, created unusual interest. Development was traced from the old straight, radial-blade type to the fan with blades curved forward and finally to a new type of multiblade fan with double-curved blades, which, according to claims made, combined the good features of the two types previously mentioned. The characteristics of the three fans were presented and comparisons made one with the other by means of pressure and power curves. The discussion centered on the relative relations of tip speed, air velocity and noise.

Meeting of the Research Section

Friday morning was reserved for the Research Session. J. R. McColl, chairman of the Committee on Research, gave an outline of the wide variety of work being conducted at the laboratory of the Research Bureau in Pittsburgh and through the extension assignments distributed among quite a number of the leading universities. At the close of its second year the Research Laboratory had not only been able to hold its own, but had far exceeded the expected range of subjects.

As an indication of the valuable research work being done, the first three papers of the session contained the most complete discussion on methods of testing insulating and building materials ever presented. Many new thoughts on this work were injected and valuable comparisons drawn between methods. A paper by F. B. Rowley was devoted to the hot-box method, including reference to double-box method designed to eliminate uncertainties due to end losses and box calibration. F. C. Houghten told of the work being done at the Engineering Experiment Station of Pennsylvania State College, with a thermal testing plate of the air-cooled variety. Results were compared with data obtained with the hot-box method and the water-cooled plate. L. A. Scipio reviewed the work that had been done in this line, called attention to numerous factors that must be taken into account, and the possibility for error in the various methods, with a summary outlining the principles to be followed in the design of apparatus to give absolute values for coefficients rather than relative or approximate values.

Ventilation Tests of Schoolrooms

A preliminary report of "Ventilation Tests of Schoolrooms at Minneapolis" was made by O. W. Armspach. Here the rooms are equipped with individual ventilating sets, with varying window construction and methods of control. During the coming season comparative tests will be made, and a wide variety of instructive data is anticipated.

Another paper, by L. A. Scipio, discussed "Chimneys for House-Heating Boilers," using as a basis the results of tests made at the laboratory of the American Radiator Co. The need of experimental work to establish data on losses and improve methods of construction was emphasized by the fact that in the average house-heating chimney the actual draft was only 37 per cent of the theoretical, as compared to 80 or 85 per cent for power chimneys.

"Dust Standards," by S. H. Katz, the final paper of the session, gave the results of a comparative study of methods for determining dust in air and a basis for establishing conversion factors so that data from the different methods employed might be comparable. The three devices considered were the dust counter, the konimeter and the sugar-tube method.

For the primary purpose of establishing closer relation with the Bureau of Standards, it was decided to hold the annual convention in Washington. For the spring meeting a year hence, invitations have been received from Buffalo and Duluth.

Keystone N. A. S. E. in New Home

Keystone Association No. 16, National Association of Stationary Engineers, being oppressed by a gouging landlord who wanted to boost the rent of its quarters by more than 100 per cent, has purchased the three-story building shown in the accompanying photograph.

It is located at 796-798 Ellicott St., Buffalo, on a lot that measures 50 x 150 ft. The size of the building is 40 x 60 ft.

THE ENGINEERS' SOLUTION OF THEIR RENT PROBLEM

The property was purchased from the Bank of Lackawanna and the necessary cash was raised by a loan secured from various members of the Association. The Keystone local is to be congratulated upon securing a home of its own.

Death of James Snedden

James Prentiss Snedden, general superintendent of the Babcock & Wilcox Co., died June 11 at Johns Hopkins Hospital in Baltimore, after having undegone two operations.

He was 58 years of age and was prominent in the boiler industry, having been actively engaged in boiler making since 1899, when he joined the Stirling boiler company.

He was born in Newmains, Scotland, in 1863, came to the United States when but 14 years old, and received his education in St. Louis and Carbondale, Ill. He learned the machinist's trade with the Rankine & Fritsch Co., at St. Louis, later becoming its manager. He planned to reorganize and buy the company, but the panic of 1893 prevented this and forced him to take up whatever work he could find for a number of years. In this way he came into the employ of the Hawley Furnace Co., of Chicago, and while with them made the acquaintance of E. R. Stettinius, who was then manager of the Stirling company.

In 1899 Mr. Snedden joined the Stirling company and shortly afterward was appointed its superintendent in charge of manufacturing. When this company bought the boiler business of the Aultman & Taylor Machinery Co., of Mansfield, Ohio, in 1905, Mr. Snedden was made vice president of the new organization, which was called the Stirling Consolidated Boiler Co. This company was in turn taken over by the Babcock & Wilcox Co. in 1906, when Mr. Snedden was made general superintendent in charge of manufacturing.

Mr. Snedden was also vice president of the Pittsburgh Seamless Tube Co., a director of the Mechanics Trust Co. of Bayonne, and a member of the Bayonne Chamber of Commerce. He leaves a wife, son and daughter.

Over 26,000,000 tons of ice was manufactured in the United States in 2,867 establishments during 1919, according to a preliminary statement of the 1920 census of manufactures. In making this ice 7,004,000 lb. of anhydrous ammonia and 1,676,000 lb. of aqua ammonia were used.

Frelinghuysen Bill Receiving Active Opposition

The National Coal Association has come out as being unequivocally opposed to any legislation intending to exercise Federal control over private business. The association believes that the Frelinghuysen coal stabilization bill is a vicious example of an effort to regulate the coal industry. This action was taken after a meeting of the Board of Directors of the association and its Government Relations Committee in Washington on June 15. In addition to determining the policy of the association, an outgrowth of the meeting was a statement pointing out where the Frelinghuysen bill is regulatory. In this statement the bill is analyzed to show that it is highly inquisitorial in its nature. Arguments are advanced to show that the provisions of the bill, if enforced, would violate the Constitution in that it attempts to force the disclosure of information concerning matters that are not within the power of Congress to control; in that it violates the guaranty against unreasonable search and seizure; in that it attempts to delegate legislative power to the executive.

The statement also asserts that the bill would allow the publication of private affairs. It is claimed that this legislation would entail great expense to the National Government for its administration and would increase the cost of producing coal, and even then would fail to accomplish its ostensible purpose.

Emphasis is given in the statement to the claim that this bill would be a forerunner and precedent for legislation of regulatory and paternal character which would apply to all lines of basic private industry.

Senator Frelinghuysen on June 17 succeeded in having the stabilization bill and the seasonal rate bill made the unfinished business of the Senate. He expressed the most determined intention to press the bills to final passage at the earliest possible moment. He spoke most regretfully of the action taken by the National Coal Association in determining to fight the stabilization bill. He expressed the opinion that the coal industry is making a vital mistake. He declared that the public is fully convinced that it is entitled to enough information as to the handling of coal to enable it to know how costs are made up.

A Correction

A diligent reader has called attention to an error in the foreword of *Power* for June 21, on page 995, in which an old Cornish pumping engine was compared with the modern equipment of Cleveland's water-supply system. The capacity of the old pump should have been given as "about 4,000,000 gal. per day;" the capacity of the new turbine pump, therefore, which was 100,000,000 gal. per day, should have been described as "25 times as much." While the error was indeed large and the published figures were obviously unreasonable, this correction does not change the significance of the comparison, which was originally determined and written on the basis of the correct proportion.

A recent ruling by the Industrial Board of the Department of Labor and Industry of Pennsylvania provides as follows: "Autogenous-welded construction will be accepted in lieu of riveted joints in the fireboxes of externally fired boilers, provided the welds are between two rows of staybolts."

New Publications

HANDBOOK OF STANDARD DETAILS. By Charles H. Hughes. Published by D. Appleton & Co., New York City. Cloth, 4½ x 7 in.; 312 pages, Price, $6.

A handbook "for engineers, draftsmen and students" is the author's description of the book. It will be found of greatest use, however, to draftsmen rather than to engineers or students, because it treats a great many subjects very briefly and deals mainly with the way in which various objects should be drawn and the standard sizes in which they are made. This very fact, however, should make it especially valuable and convenient to draftsmen, who do not like to go through a lot of reading matter to find the information they need. Probably 90 per cent of the total space is covered by tables and drawings and only about 10 per cent by solid reading matter. The scope of the book is wide, as indicated by the main section headings, which follow: Drawings, fastenings, power transmission, pipe, tubes and fittings, rope and chain fittings, miscellaneous details, structural details and useful tables.

BIBLIOGRAPHY ON COAL, MINERAL AND PETROLEUM RESOURCES

The United States Bureau of Foreign and Domestic Commerce has received a bibliography, prepared by an Argentinian, on coal, mineral and petroleum deposits in Argentina. The lists may be obtained through the district offices of the Bureau, which are located in New York, Boston, Chicago, St. Louis, New Orleans, San Francisco, Seattle, and Manila, P. I. Inquiries should refer to Exhibit No. 46789.

Society Affairs

The American Society of Mechanical Engineers has announced that its next spring meeting will be held at Atlanta, Ga., May 8-11, 1922.

The Stoker Manufacturers' Association, at its annual meeting at Stockbridge, June 14-16, elected the following new officers: President, Maxwell Alpern, American Engineering Co., (Phila.); vice president, S. A. Armstrong, Underfeed Stoker Co. of America, (Detroit); treasurer, Richard D. Holton, Laclede-Christy Co., (St. Louis); secretary, J. G. Worker, Phoenix Manufacturing Co., (Eau Claire, Wis.).

Personals

D. B. Morris, of the Morris Company, Georgetown, S. C., has announced that he is now erecting and will operate a twenty-ton ice plant in that city.

E. S. Jones, previously assistant engineer for the Pacific Gas and Electric Co., Sacramento, Cal., has been appointed engineer for the Honolulu Gas Co. Ltd., Honolulu, H. I.

J. H. McNally, who was formerly with Weston Dodson & Co., Inc., Bethlehem Pa., has been made vice president and fuel engineer of the Fuel Service Co., New York City.

Charles W. McKay, formerly president of the firm of McKay & Sherman of Chicago, has joined the American Appraisal Co. as engineer in the public utilities department.

Asa M. Mattice, previously with the Remington Arms Union Metallic Cartridge Co., New York City, has become advisory engineer for the Remington Arms Co., Inc., New York City.

C. I. Rodes has been appointed chief hydraulic engineer for the California State Railroad Commission, after two and a half years' service, in place of Chester H. Loveland, who resigned May 1.

H. W. Clarke has resigned his position as manager of the publicity department of the Chicago Pneumatic Tool Co. to become business manager of *Coal Age,* one of the McGraw-Hill publications.

C. E. Davies is now the managing editor of *Mechanical Engineering,* the journal of the American Society of Mechanical Engineers. Mr. Davies was formerly associate editor, and succeeds Lester G. French, who died recently.

E. J. Condon, Jr., has been elected assistant general manager of the Intermountain Railway, Light and Power Co., Colorado Springs, Col., and will have charge of the operation and maintenance of the company's eight central stations.

R. F. Hetzel is no longer with the engineering department of the Ford Instrument Co., New York City, having become chief engineer and assistant to the general manager of the Goetze Gasket and Packing Co., of New Brunswick, N. J.

James M. Barry has been promoted from the position of manager of the Eastern division of the Alabama Power Co. to that of assistant chief engineer. Mr. Barry was previously connected with the Northwestern Power Co. and the Great Western Power Co.

Miscellaneous News

A conference for Furthering International Standardization was held in London recently by the secretaries of the national standardizing bodies of Belgium, Canada, Great Britain, Holland, Norway, Switzerland and the United States. Dr. P. G. Agnew, secretary of the American Engineering Standards Committee, has recently returned from a short trip through France, Switzerland and Germany after attending the conference, and reports that those present at the meeting felt it was very successful.

The Specifications and Drawings for the mechanical and electrical equipment of the Jitsugetsutan (Lake Candidius) hydroelectric project of the Taiwan (Formosa) Electric Power Co. are now on file at the New York office of the United States Bureau of Foreign and Domestic Commerce at 734 Customhouse, New York City. Reference should be made to File No. 29632. The station will comprise six 20,000-kw. a.c. units coupled to Pelton wheels under a 1,370-ft. head, water-diven exciter units, transformers and other auxiliary equipment.

Business Items

The Spray Engineering Co. has moved into new offices at 60 High St., Boston. The factory and shipping department, however, remain at 77 North Washington St.

The Master Tool Company, 203 East St. Clair Ave., Cleveland, Ohio, has been organized as a corporation under the laws of the State of Ohio to manufacture a new line of pneumatic tools. The officers of the company are: J. Nightingale, president; Charles F. Overly, vice president and general manager; William Eckert, secretary-treasurer. C. F. Overly is manager of sales.

Trade Catalogs

The Ridgway Dynamo and Engine Co., Ridgway, Pa., has issued a new bulletin on its line of unaflow engines.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., is distributing a new bulletin on "Centrifugal Pumps for Ice and Refrigerating Plants."

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoting	June 14 1921	June 21 1921
Pool 1,	New York	$3.45	$3.25@3.65
Pocahontas,	Columbus	3.45	3.25@3.50
Clearfield,	Boston	2.25	1.85@2.60
Somerset,	Boston	2.75	2.15@3.00
Pittsburgh,	Pittsburgh	1.95	1.75@1.90
Kanawha,	Columbus	2.20	2.00@2.25
Hocking,	Columbus	2.15	2.00@2.25
Pittsburgh No.8	Cleveland	2.10	2.00@2.15
Franklin, Ill.,	Chicago	3.00	2.25@3.50
Central, Ill.,	Chicago	2.50	2.00@2.75
Ird. 4th vein,	Chicago	2.60	2.25@2.75
Standard,	St. Louis	1.75	1.65@1.85
West Ky.,	Louisville	1.90	1.75@2.25
Big Seam,	Birmingham	2.50	2.25@2.75
S. E. Ky.,	Louisville	2.25	2.00@2.50

New York—On June 28, Port Arthur light oil, 23@25 deg. Baumé, 4¼c. per gal. 30@35 deg., 6c. per gal. f.o.b. Bayonne, N. Y.

Chicago—June 18, for 24@28 deg. Baumé, 35@45c. per bbl.; 32@34 deg. 1½@2c. per gal. In-tank cars f.o.b. Oklahoma refinery, or freight adjusted.

St. Louis—June 18, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 40c. per bbl.; 25@28 deg., 45c.; 28@30 deg. 50c.; 32@34 deg. 1¾c. per gal.

Pittsburgh—On June 20, f.o.b. refinery; Pennsylvania, 36@40 deg., 3¾c. per gal.; Oklahoma, 24@30 deg. 35c. per bbl., gas oil, 32@34 deg., 1¾c. per gal., 36@38 deg., 2¼c. 38@40 deg. 2⅝c.

Philadelphia—On June 20, 26@28 deg. Baumé, Oklahoma, 3½c. per gal; 30@34 deg., Oklahoma (group 3) 2¾c. per gal.

Cincinnati—June 18, for 22@28 deg. Baumé, 6½c. per gal.

Cleveland—June 18, for 22@28 deg. Baumé, 5½c. per gal.

New Construction

PROPOSED WORK

N. Y., New York—Bway.-170th St. Holding Corpn., c/o D. Lang, Archt. and Engrs. 110 West 34th St., is having plans prepared for a 6 story, 100 x 165 ft., apartment on Bway. and 170th St. About $350,000.

N. Y., New York—C. Kreymbroy, Archt. and Engr., 2534 Marion Ave., is preparing plans for two 5 story apartments on Kingsbridge Rd. About $200,000 each. Owner's name withheld.

N. Y., New York—The New York Edison Co., 130 East 15th St., is having plans prepared for a 1 story, 25 x 60 ft., substation at 38 Bowery. About $130,000. W. Whitehill, 12 Elm St., Archt. and Engr.

N. Y., New York—The New York Life Insurance and Trust Co., 52 Wall St., is having plans prepared for a 5 story office building on Madison Ave. and 65th St. About $500,000. F. E. Newman, 120 East 40th St., Archt and Engr.

N. Y., New York—The Valhalla Corpn., c/o Moore & Landslidel, Archts. and Engrs., 3d Ave. and 148th St., is having plans prepared for a 5 story 92 x 122 ft. apartment on Ryer Ave. near 181st. St. About $350,000.

N. J., Trenton—The Central Labor Union, 47 North Clinton Ave., plans to build an 8 story, 110 x 180 ft., lyceum. About $1,000,000. Address F. J. Schnorbus, 362 Cleveland Ave. Architect not selected.

Pa., Altoona—The School Dist. will receive bids until July 1 for mechanical warm air furnace plant, to include blower with a minimum capacity of 25,000 cu.ft. per minute, the motor to be 3 phase, 10 hp. type, equipped with starting and switch boxes. Furnace or furnaces to have a heating capacity of not less than 22,000 cu.ft. per minute. N. W. Decker, Secy.

Fla., Moore Haven—The City will receive bids until July 8, for a 150 hp. oil engine, etc. and a 125 kva. generator, etc. About $20,000. T. E. Frederick, Engr. Noted May 31. Former bids rejected.

N. C., Chapel Hill—The University of North Carolina plans to extend and enlarge the light, water and sewer systems. About $100,000. T. C. Atwood, Engr.

N. C., Gastonia—The City plans to build high school. About $500,000. Architect not selected.

Miss., Jackson—The State Bond. Impvt. Assn. will soon award the contract for a power house at the Mississippi Agricultural and Mechanical College, Starkville. T. C. Link, supervising archt., Dir. Pub. Wks., P. O. Box 636.

Ill., Bloomington—The Illinois Wesleyan College, c/o T. Kemp, pres., plans to build a college to include library, gymnasium, auditorium, dormitory and school buildings. About $700,000. Architect not selected.

O., Cleveland—The Cleveland -Electric Illuminating Co., Illuminating Bldg., is having plans prepared for a 1 story power substation on Cedar and Lee Rds. About $40,000. A. Gallaher, Illuminating Bldg., Archt.

O., Cleveland—City will receive bids until July 1 for the installation of electric and power wiring for the city hospital buildings. About $150,000. E. Shattuck, City Hall, Clk.

Ind., Auburn—The Auburn Chamber of Commerce plans to build 4 story hotel and stores. About $500,000. Architect not selected.

Ind., Evansville—The Evansville College, 519 Vine St., is having plans prepared for a 2 story power plant and gymnasium. About $400,000. Miller, Fullenwider and Dowling, 6 North Michigan Ave., Chicago, Ill., Archts.

Ind., South Bend—The Notre Dame University plans to build a 2 story dormitory and gymnasium. About $450,000. Architect not selected.

Wis., Janesville—The Bd. Educ. will receive bids until July 11 for a 3 story, 180 x 210 ft. high school and 40 x 50 ft. boiler house on South Main St. About $600,000. Van Ryn & De Gelleke, 114 Grand Ave., Milwaukee, Archts.

Kan., Ottawa—City, c/o E. W. Cusick, Clk., will receive bids until July 8, improving water-works system and filtration plant. About $165,000. Black & Veatch, Mutual Bldg., Kansas City.

Ia., Oskaloosa—R. J. Walsh, Davenport, is having plans prepared for a 7 story, 40 x 110 ft., hotel including a steam heating system. About $350,000. Clousen & Kruse, Central Bldg., Davenport, Archts.

Minn., Forest Lake—City, c/o T. Arends, village recdr., is having plans prepared to complete water-works system involving steel tower and tank, wells, pumps, machinery, equipment, mains, etc. About $70,000. Druar & Mininowski, 500 Globe Bldg., St. Paul, Engr.

Neb., Loup City—City, c/o J. Minshall, Clk., will soon award the contract for 14 hydrant 4-4 in. gate valves, one 8 x 8 vertical single acting pump, 10 hp. motor, etc. About $65,000. Heningson Eng. Co., Natl. Bldg., 15th and Harney Sts., Engrs.

Neb., Omaha—The Worlds Realty Co., 4110 Farnum St., is receiving bids for a 5 story, 110 x 132 ft., theater including a steam heating system, on 15th and Douglas Sts. About $500,000. C. Howard Crane, 400 Huron Bldg., Detroit, Mich., Archt.

Mont., Helena—The State Bd. Educ. has engaged Bakke & Forbes, Archts., to prepare plans for a heating plant in State University at Missoula, about $50,000; and F. Wilson, Archt., Bozeman, to prepare plans for a heating plant in State University at Bozeman, about $50,000.

Utah, Salt Lake City—Masonic Club, Wilson Hotel, plans to build temple on South Temple St. About $750,000. Architect not selected.

Col., Colorado Springs—The city plans to build auditorium. Estimated cost $350,000. C. E. Thomas and McLaren & Hetherington, 224 Hagerman Bldg., Archts.

Ont., Mille Rockes—Provincial Paper Mills, Ltd., 56 University Ave., plans to build boiler house including new horizontal boilers. About $20,000.

Ont., Goderick—The town plans to build filtration plant to include chlorination equipment and new pumps. About $25,000. E. H. Darling, Home Bank Bldg., Hamilton, Engr.

Ont., London—H. A. Brazier, city engr., City Hall, will receive bids until July 30, for 4 horizontal centrifugal sewage pumps, each 1,500 imperial gal. per minute capacity, to operate against a 50 ft. head, pumps to be electrically operated, also motors and electrical control equipment.

Ont., Port Elgin—The town council plans to build new electric lighting and power distribution plant. R. Cottrill, Chn. Comn.

Ont., Southampton—The town council plans to vote on bonds to build electric lighting and power distribution plant. R. McVittie, Chn. Comn.

Ont., Wallaceberg—The Separate School Bd. will soon receive bids for the installation of steam heating and ventilating systems in an 8 roomed school. About $30,000. M. McCarron, Secy.

CONTRACTS AWARDED

Vt., Saxtons River—Vermont Academy will complete alterations to a 2 story dormitory and build a 1 story, 50 x 50 boiler house on campus. About $75,000. W. C. Fowler, Supt. Work will be done by day labor.

Fla., St. Petersburg — The City has awarded the contract for waterworks plant, electrically driven, to replace present steam plant, involving 4 centrifugal pumps to have a 1,000 gal. per hour capacity, to Fairbanks & Morse Co. and Layne & Bowen Co. Cost between $52,000 and $64,000. Noted May 23.

Ind., Indianapolis — The Best-Grand Laundry, North Capitol Ave., has awarded the contract for the construction of a 2 and 3 story, 67 x 200 ft., laundry to include steam heating system involving a 300 hp. boiler. to Brandt Bros., Chamber of Commerce Bldg. Estimated cost $100,000.

Ill., Freeport—The Catholic Congregation has awarded the contract for a 1 story church, including a steam heating system, to L. T. Brandt, 157 Union St., $225,389.

Kan., Topeka—The City has awarded the contract making power plant improvements, for steam flow meters to Machinists Electric Co., 108 West 8th St., $1,075; for superheater, installation for 250 hp. water tube boiler to C. H. Carr, Reliance Bldg., Kansas City, $1,545; for 24 in. twin strainers to The Elliott Co., Kansas City, Mo., $3,078; for stoker installation for 2,250 hp. boilers to Laclede-Christy Products Co., Ry. Exch. Bldg., St. Louis, Mo., $5,420; for 2 CQ recorders to Republic Flow Meter Co., Kansas City, Mo., $400.

Minn., St. Cloud—Stearns Co. has awarded the contract for the installation of plumbing, draining, water supply, gas piping, deep well and pumping equipment, boiler plant, vacuum, heating and ventilating systems also automatic temporary regulator to Healy Plumbing and Heating Co., 278 West 4th St., St. Paul. About $55,000.

Minn., St. Paul—The State Bd. of Armory Supervisors has awarded the contract for 3 frame hangars, including wiring, heating, light plant, to Carlsted Bros., 542 Builders Exch. Bldg., Minneapolis, $35,828.

Tex., Stamford—City has awarded the contract for the installation of pumping machinery in city pumping station to The Etter Co., Sherman. About $17,200.

Cal., Ventura—Ventura Co. has awarded the contract building power plant and transmission lines in connection with proposed dams to Bent Bros., Central Bldg., Los Angeles. Total cost including dams, about $1,259,000.

Ont., Petrolea—The Canadian Oil Co. will build a new boiler house, pump house and brick stack. About $50,000. Above work will be done by day labor. Contract awarded for seven 150 hp. boilers to J. Ingles & Sons, Toronto.

Ont., Toronto—Toronto Conservatory of Music, 135 College St., has awarded the general contract for the construction of a 1 story, 20 x 40 ft., central oil burning and steam heating plant to Crescent Concrete Co., Temple Bldg.; for oil fuel boilers to Canadian Allis-Chalmers, 212 King St., W.; for 2 oil storage tanks to Toronto Iron Wks. Limited, Ft. of Cherry St.; for circulating pump and motors to Canadian Blower & Forge Co., Bank of Hamilton Bldg.; for steam generator to Darling Bros., 77 York St.; for chimney to Cuslodes Canadian Chimney Co., Limited, Kent Bldg. About $25,000.

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POWER

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Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place.

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Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

CIRCULATION OF THIS ISSUE, 27,100 COPIES

Moments with the Ad Editor

THIS terse comment greeted our eyes when we opened the mail one day last week. It was written across the face of an advertisement torn from a recent issue of POWER, and referred to certain statements and figures embraced in a fanciful idea of the copy writer.

As proof that these statements were inaccurate this reader and correspondent of ours backed up his comment by diagrams and supporting computations. He showed conclusively that the copy writer is not as adept with log table and slide rule as he might be.

We plead "not guilty" Mr. Reader—for the advertisement was written by the advertiser—but we are glad indeed to have heard from you for this incident provides an opportunity to get across a serious message to the advertiser.

Here it is.

A trick caption, or a clever headline or idea, that cannot bear keen scrutiny is just as harmful to an advertiser as would be inaccuracies about the performance or value of the product itself. *One* such statement, even though of minor importance, may be sufficient to discountenance the reader's belief in *every* claim made by the advertiser. *Every statement presented must be absolutely accurate.*

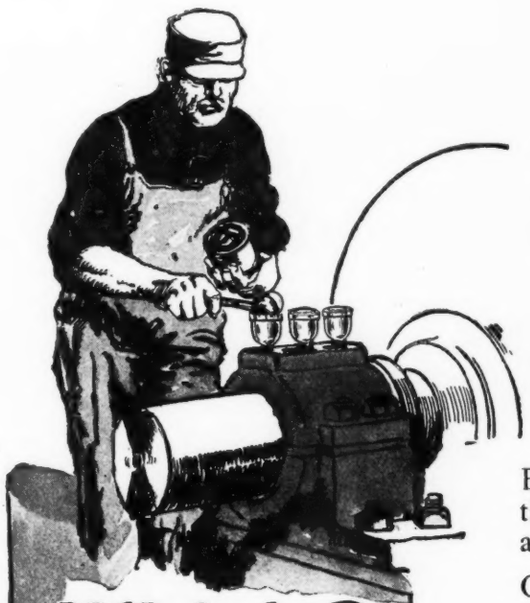
Advertisers in POWER reach discriminating buyers in our readers. They must put forth their best arguments to prove that their particular products will effect the economies that the editorial pages point out as being necessary for efficient power plant operation. Their every statement will be put to the test—for they are studied by practical operating men looking for knowledge based on facts that cannot be controverted.

Every engineer who is determined to keep his plant up-to-date on design, methods of operation and equipment, reads POWER each week *from cover to cover.*

We often have been asked by our advertisers:
"DO THEY READ OUR ADS?"
Replying, in the slang of the day,—
"WE'LL SAY THAT THEY DO."

THE DOMINANT CONSERVATION FACTOR

KEYSTONE Lubricants Conserve Cost of Oiling Labor



Which?

Once every seven weeks or twice every day

Because of the high cost of labor, of every grade, the time and labor-saving features of Keystone Grease alone should be sufficient reason for its adoption.

One user writes that he fills his grease cups but *once in seven weeks instead of twice every day*—and is receiving a vastly more efficient lubricating service since adopting the Keystone Venango Gravity Grease System and

KEYSTONE GREASE

THE WORLD'S GREATEST LUBRICANT

"Makes the Most Efficient Mechanical Unit MORE Efficient"

Keystone Grease is the result of scientific investigation covering the experience of a lifetime in the development of every phase of lubrication.

Industrial America Moves on Keystone Grease

Where Keystone Grease is used, not only are oiling costs cut to the core, but infinitely better lubrication is secured, more power released for increased production, hot boxes and scored bearings disappear for all time, costly repairs and expensive shutdowns necessitated by improper lubrication are entirely eliminated.

Learn more about the world-wide lubrication service Keystone Grease has built on a purely efficiency basis. Why not arrange for a trial installation of the Keystone Venango Gravity Grease System at our expense?

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

THE KEYSTONE LUBRICATING COMPANY

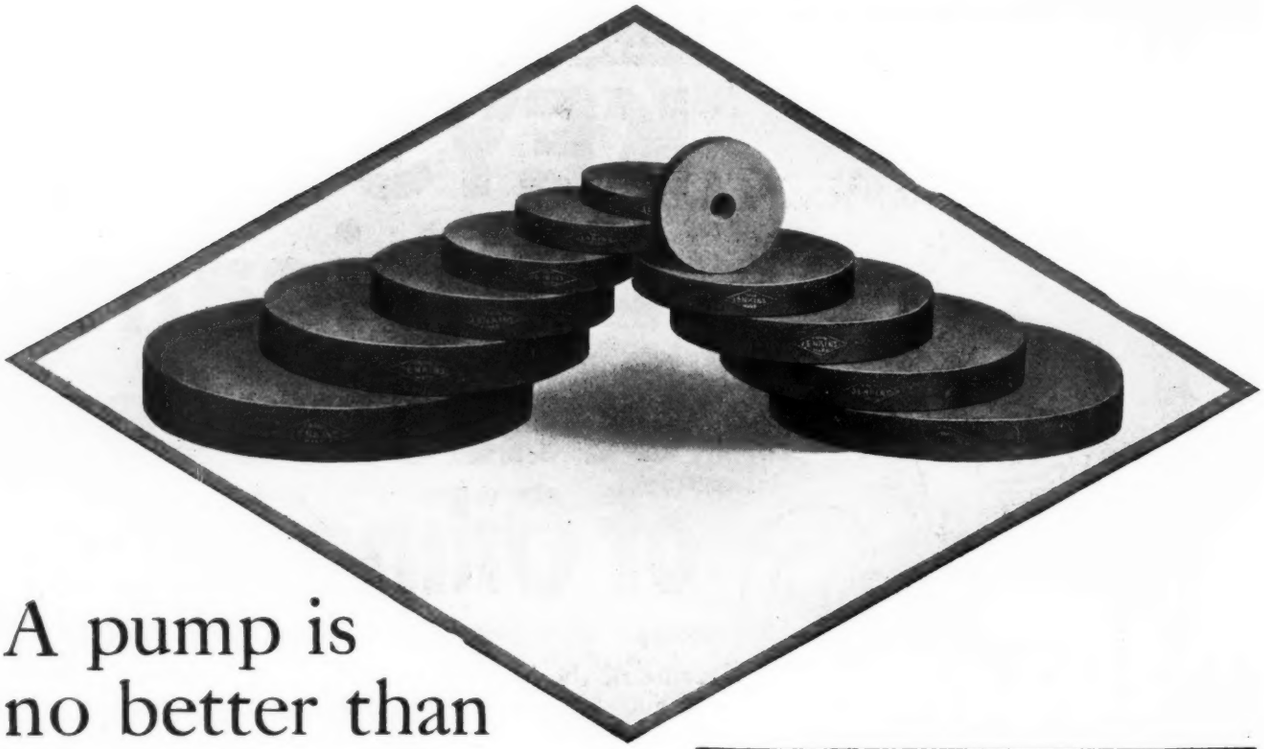
New York
Boston
Pittsburgh
Chicago
Detroit

Executive Office and Works
Philadelphia, Pa.
Established 1884

St. Louis
Denver
San Francisco
Minneapolis
Houston

Agencies in Principal Countries Throughout the World

UNIVERSALLY KNOWN UNIVERSALLY USED



A pump is no better than its pump valve

JENKINS PUMP VALVES are the result of years of experience in the mechanical rubber goods line. Skillful compounding of the proper ingredients and the careful supervision in the progressive stages of manufacture go to make up the pump valve which bears the Jenkins name and Diamond Mark — a symbol and guarantee which is placed only on genuine Jenkins Bros. products.

Maximum efficiency is obtained from pumps fitted with Jenkins Pump Valves.

In panel at right is a schedule of compounds and recommendations for various services. Write for further information if special requirements are to be met.

Jenkins Pump Valves are sold at supply houses everywhere.

The Jenkins Diamond Mark is your protection.

JENKINS BROS.

New York Boston Philadelphia Chicago
Montreal London Havana

FACTORIES: Bridgeport, Conn.; Elizabeth, N. J.; Montreal, Canada.

Schedule of compounds and services for which Jenkins Pump Valves are recommended:

No. 80. Hot Water Valve, for pressures up to 250 pounds, temperature not less than 180 degrees, nor more than 300 degrees. For Air Compressors these valves have been successful. While extremely hard, they possess sufficient elasticity to insure absolute tightness under various conditions of pressure.

They will give entire satisfaction in oils, naphtha, syrups, acids, and other destructive fluids.

No. 88. For warm water up to 175 pounds pressure; cold water 50 to 400 pounds pressure.

For mining and high pressure service, or for elevator service, where the water is often slightly oily, these valves have proved equal to every requirement.

No. 92. Cold Water Valves, for pressures up to 100 pounds.
No. 15. For Cold Water pressures up to 75 pounds, and for Condenser Air Pumps and similar service.

The question often arises as to which compound is best suited for use on vacuum pumps. This can be answered only when the service in which the pump is used is known. For example, the pump used on the returns of a vacuum heating system which often carry considerable oil, would require a different valve from a pump used in dry vacuum service. Ordinarily any of our softer valves will give good service on vacuum work, but to secure the best valves for a specific purpose a brief description of the service in which the valves are to be used is necessary when ordering.

Some types of Condenser Air Pumps use valves that e held closely to the seat at center, curving up from that point to outer edge of valves as they lift; for this work, also for square or oblong flap valves, a soft valve is required, and for this purpose, we recommend our No. 15 Compound. It is a tough, flexible valve, and will stand water heated 120 to 180 degrees under moderate pressure, and give long service.

13. J

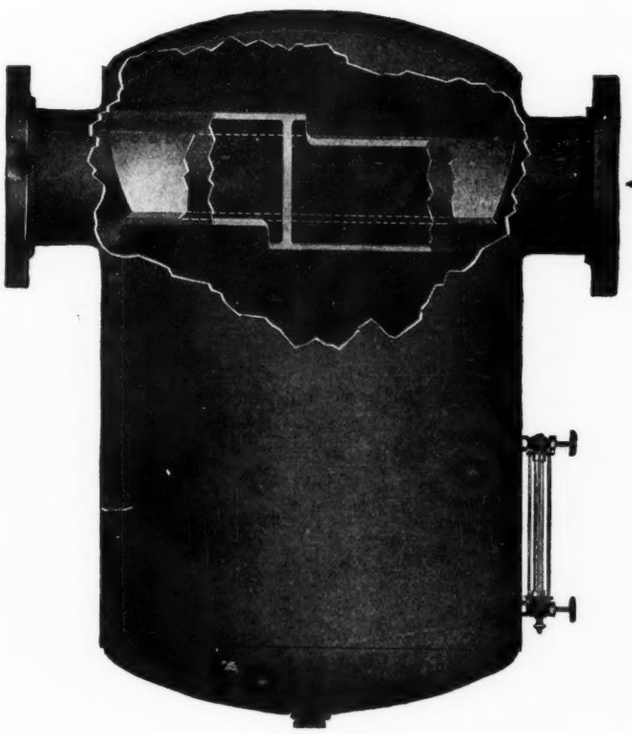
Jenkins Valves

SINCE 1864

Welderon Receiver Separators

—by means of welding, the receiver is simply hung on the steam line. Hence the name—"Weld-'er-on."

It obtains the advantage of a separator of large capacity without introducing a weak point in the steam line.



This "through-pipe" construction relieves the body of the Separator from stresses and strains due to vibration, expansion and contraction.

Welderon Separators are built in horizontal and vertical patterns.

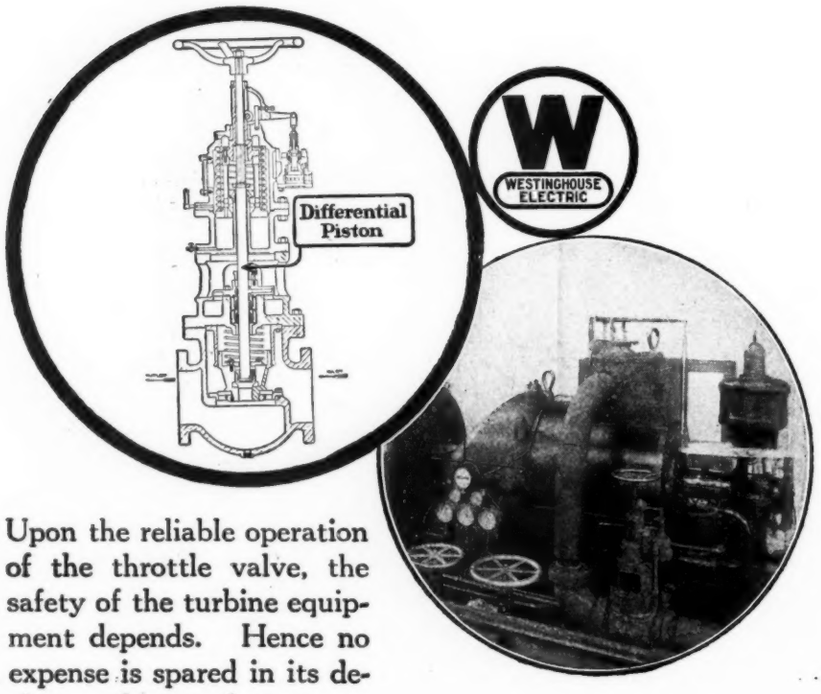
Ask for Bulletin F.
It is fully descriptive.

E-352

ELLIOTT PRODUCTS
Condensers
Air Ejectors
Twin Strainers
Twin Filters
Feed Water Heaters
Steam Separators
Receiver Separators
Blow-Off Valves
Oil Filters
Steam Traps

ELLIOTT COMPANY
Pittsburgh, Pa.
GENERAL SALES OFFICES: JEANNETTE, PA.
District Sales and Service Offices in Principal Cities

Westinghouse Automatic Throttle Valve



Upon the reliable operation of the throttle valve, the safety of the turbine equipment depends. Hence no expense is spared in its design and manufacture to assure a high degree of reliability. This valve is built in our own factory.

It is a balanced valve. It is forced to the closed position by a powerful spring which is released when the steam pressure beneath the differential piston is released by the action of the safety stop.

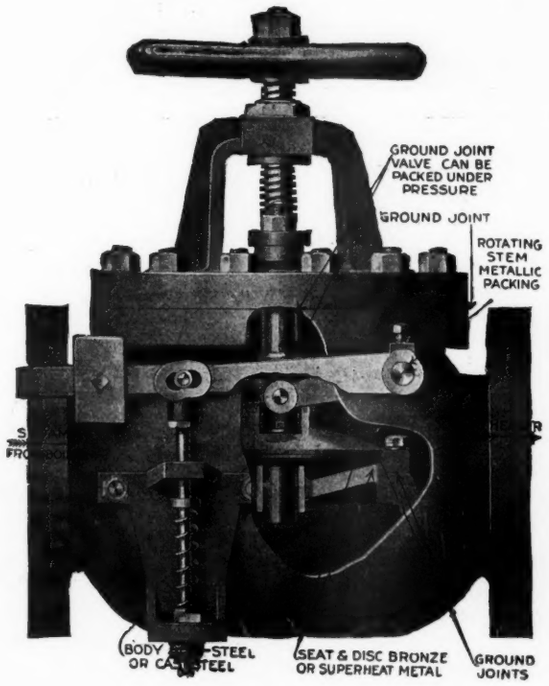
The closing force is enormous and rendered non-destructive by the action of the oil dashpot.

The valve seats are made of special steam-resisting metal. The seats are bolted in place as simply as a pipe flange. This is expensive construction, but it prevents leakage and facilitates replacement.

Westinghouse Electric & Mfg. Co.
East Pittsburgh, Pa.
Offices in all Principal American Cities

Westinghouse

Boiler Protection That Can Be Relied Upon Completely



Protect your plant against serious accident following the sudden reversal of steam flow into a damaged boiler.

Stop the remaining boilers from pouring out their steam into that boiler by equipping all boiler outlet connections with

STRONG Non-Return Valves

These valves will automatically cut out the damaged boiler and prevent the entrance of steam by way of the header.

Special attention is directed to the simple and positive acting *outside* mechanism. Perfect cushioning is obtained by the weighted lever and dash pot. The valves will not hammer, stick or chatter.

Secure complete details about the application and operation of these valves by mailing the attached coupon.

The Strong, Carlisle & Hammond Co.
Cleveland, Ohio

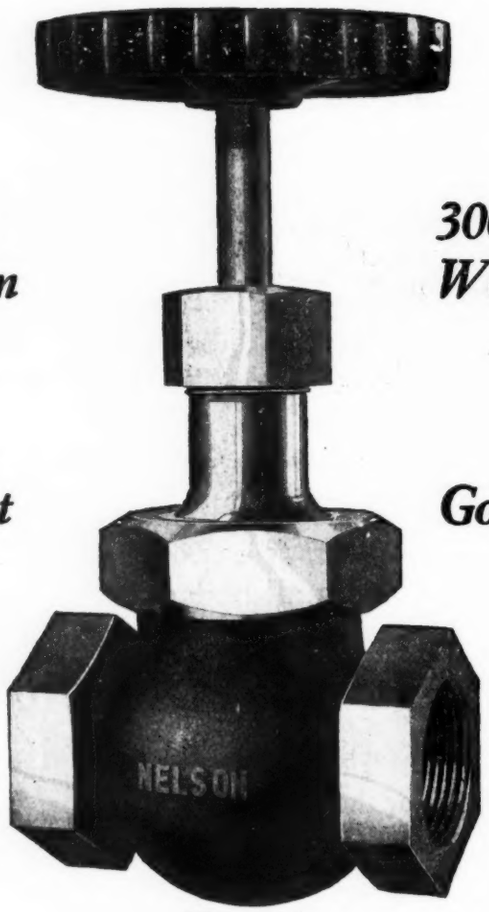
The Strong, Carlisle & Hammond Co., Cleveland, O.
Gentlemen: Please send me a copy of your latest Catalog No. 18-P at your earliest convenience.
Name.....
Address.....
.....1921
6-28-21

NELSON

Bronze Valves for Superheat

Monel Seat, Disc and Stem

300 lbs. per sq. in. Working Pressure



Union Bonnet

Good for 550° F.

No. 53-A

Can be supplied in angle type or with flanged ends
Sizes, ¾ to 3 inches

NELSON VALVE CO.

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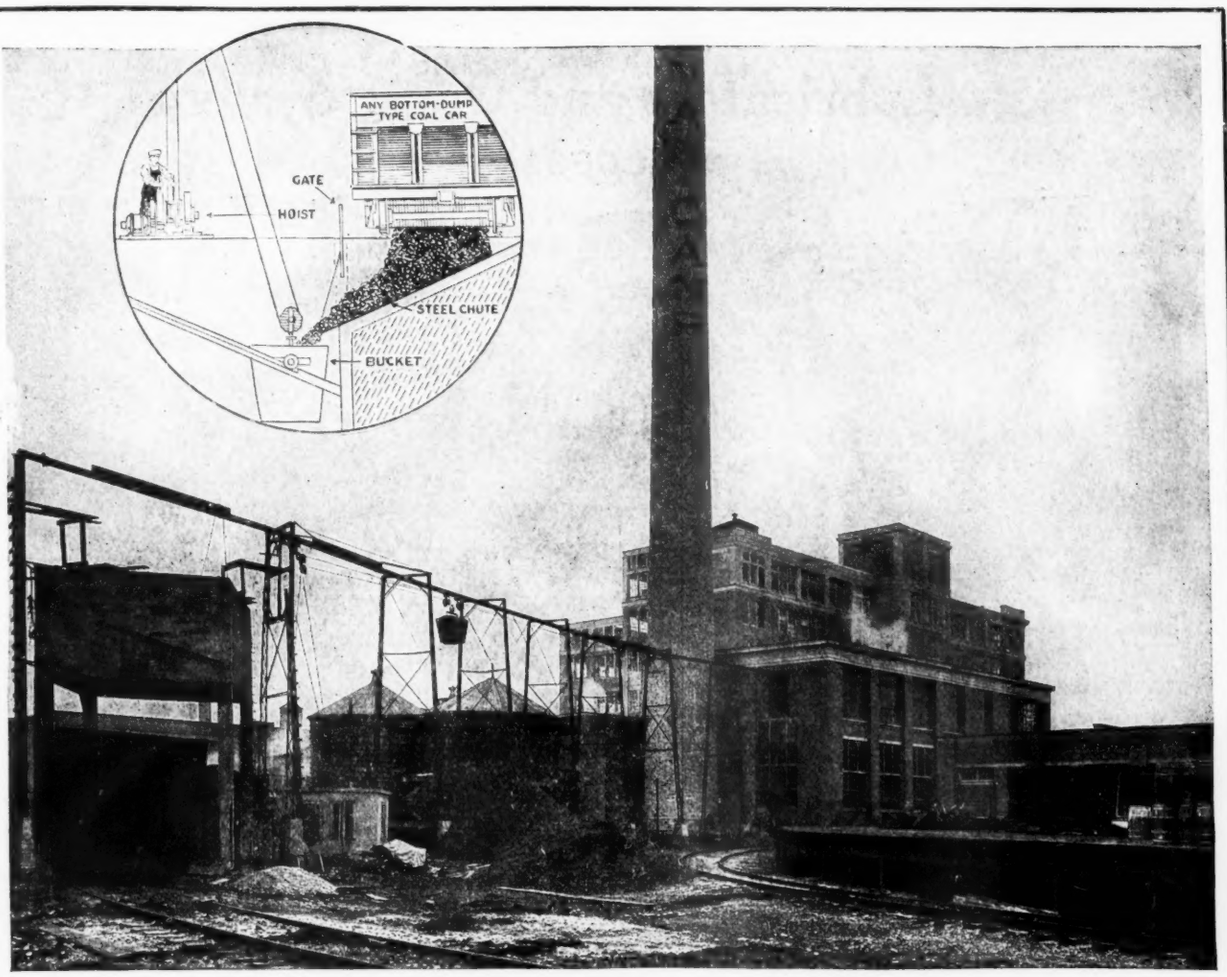
BALTIMORE—8 E. Lombard St.
BOSTON—131 State Street
BUFFALO—582 Ellicott Square
CHICAGO—550 West Lake Street
CLEVELAND—550 Kirby Bldg.

CHESTNUT HILL
PHILADELPHIA

DETROIT—242 Larned St., West
NEW YORK—90 West Street
PITTSBURGH—517 Liberty Ave.
SAN FRANCISCO—75 Fremont St.
SYRACUSE—504 City Bank Bldg.



Godfrey Monorail I-Beam Installation at Van Camp Packing Co.

Handling Coal and Ashes At Low Cost with a Godfrey Conveyor

In Indianapolis the Van Camp Packing Company have been using a GODFREY CONVEYOR for 18 months to unload, store and reclaim their coal. The same system is used to carry their ashes from boiler room to an outside receiving tank. During this time they have saved a considerable amount of money on the items of labor, demurrage charges and wasted time. Their coal is unloaded from car to storage by the service of only ONE MAN. No shoveling is required. Their Superintendent stated the cost of conveying coal to bunkers in boiler room is only 6 cents per ton.

Your Company Can Do the Same

Godfrey Engineers in your territory will be glad to make recommendations and estimates. No obligation. Just tell us where and when.

Godfrey Conveyor Co.

Factory and General Offices:

113 13th St., Elkhart, Indiana

Originators, Patentees and Manufacturers of
Conveyors operating gravity-filled bottom dump bucket over monorail.

New York: 1144 Grand Central Palace.
Boston: 141 Milk St.
Providence: 801 Union Trust Bldg.
Philadelphia: 736 Drexel Bldg.
Pittsburgh: 1404 Arrott Bldg.
Chicago: 223 West Erie St.
Minneapolis: 2324 Harriet St.
Canada: Toronto, 106-110 Richmond St., West.

TEAR OFF AND MAIL TODAY

Godfrey Conveyor Co.
Elkhart, Ind.

Please send descriptive catalogue of your conveyors as advertised in June 28th issue of Power. We handle .....tons of coal a year.

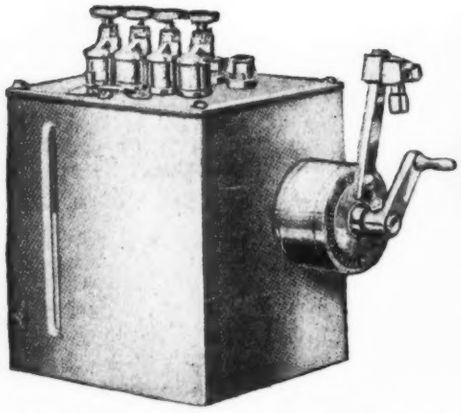
Company.....

City.....

State.....

By.....

Lubricators and Oiling System Accessories



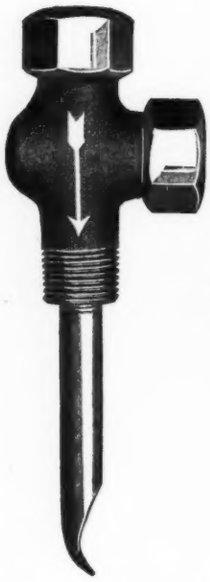
Four Feed Model T Lubricator. Made in any capacity and number of feeds.

The highest-grade, moderate-price force-feed lubricator available. Adopted as standard by well-known engine and machinery builders. Ask for Bulletin 50-B.

Sight Flow Indicators

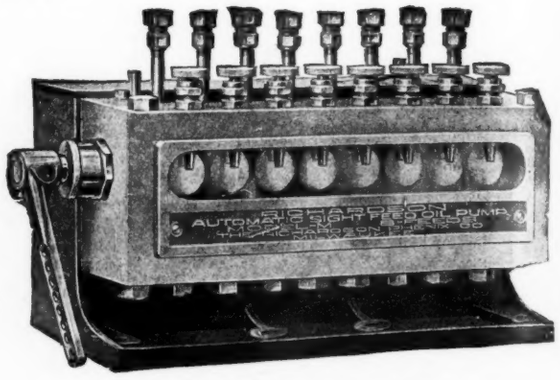
For use wherever it is desired to see whether or not the oil or any other liquid is flowing —used on transformers, on oil and water circulating pipes of Diesel and other engines, compressors, hydraulic turbines, chemical and all industrial processes.

Bulletin No. 30-M.



Terminal Check Valve

Insures correct oil atomization for cylinder lubrication with all engines and compressors.



Model M Force-Feed Lubricator

From One to Twenty-Two Feeds

The Only High-Class Lubricator Especially Suited to Diesel Engines and Other Similar Lubrication Requirements

Ask for Bulletin 60-A

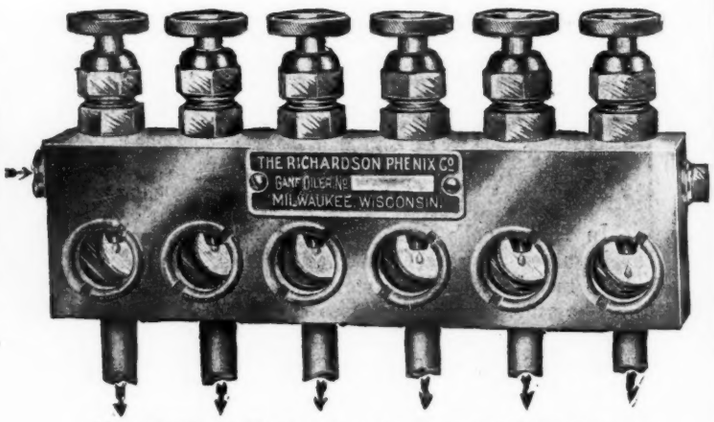
Multiple Sight Feed Oilers

Used wherever it is desired to control the flow of oil from central points of distribution.

Made in a number of styles.

Write for Bulletin No. 30-M.

Sight Flow Indicator



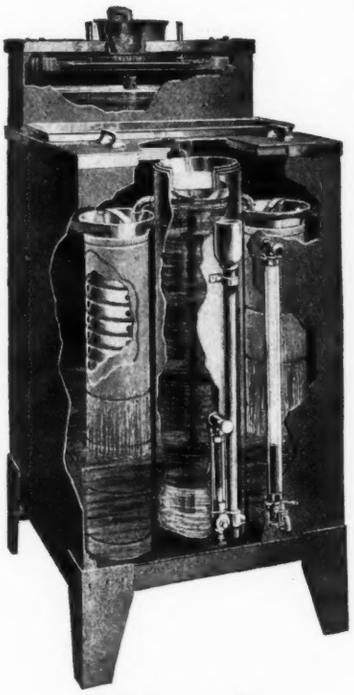
Multiple Sight Feed Oiler for Centralized Distribution

THE RICHARDSON

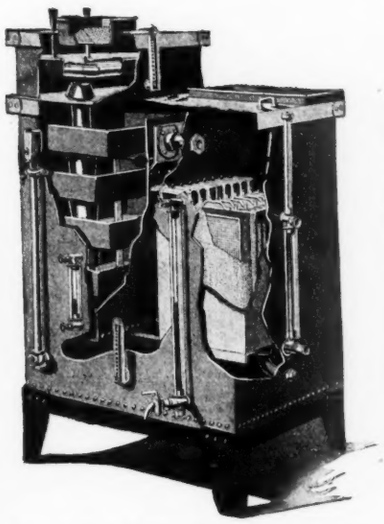
Lubrication Engineers

124 Reservoir Ave.

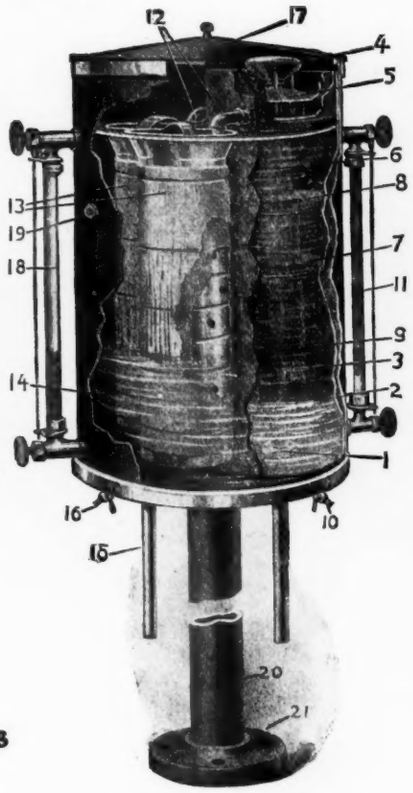
High Grade Oil Filters for All Purposes in Any Desired Capacity



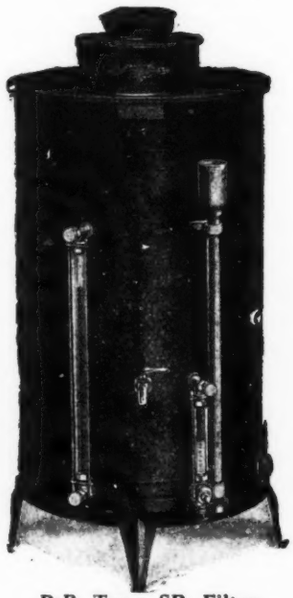
R-P Type S Filter



No. 5 R-P Type "A" Power Plant Oil Filter



R-P Type R Filter



R-P Type SR Filter

Oil Filters and Complete Oiling Systems

for

General Industrial Power Plants
Public Service Power Plants
Hydro-Electric Power Plants
Refrigeration Plants
Marine Power Plants
Cutting Oil Systems
Quenching Oil Systems

Force-Feed Lubrication for

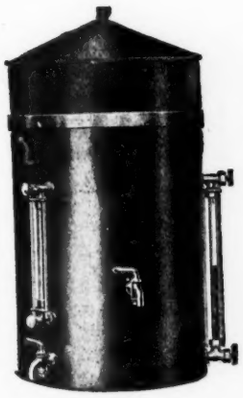
Saw Mills — Paper Mills
Steel Mills — Forge Shops
Machine Tool Works
Power Plants of All Industries

Oil Reclaiming Apparatus

for

Diesel Engine Oil
Motor Vehicle Engine Oil

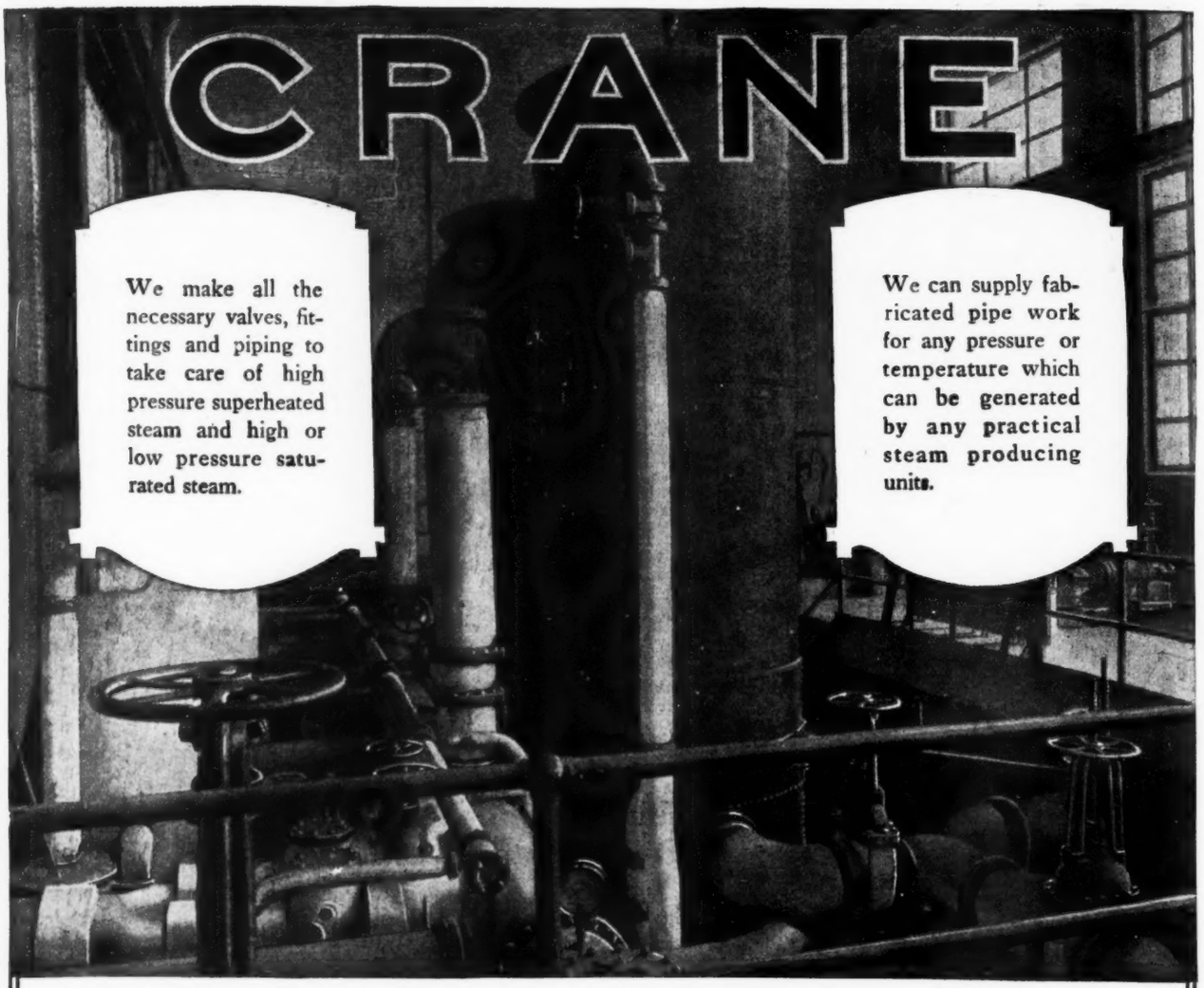
Write for Literature



R-P Portable Filter

—PHENIX CO.

and Manufacturers
Milwaukee. Wis.


CRANE
We make all the necessary valves, fittings and piping to take care of high pressure superheated steam and high or low pressure saturated steam.
We can supply fabricated pipe work for any pressure or temperature which can be generated by any practical steam producing units.

CRANE
POWER PLANT EQUIPMENT

is designed with the object of producing an efficient system having the longest possible life, the least liability of a break-down, and a minimum cost of up-keep.

SALES OFFICES, WAREHOUSES AND SHOWROOMS:

BOSTON, SPRINGFIELD, HARTFORD, BRIDGEPORT, ROCHESTER, NEW YORK, HARLEM, BROOKLYN, ALBANY, PHILADELPHIA, READING, ATLANTIC CITY, NEWARK, CAMDEN, BALTIMORE, WASHINGTON, SYRACUSE, BUFFALO, SAVANNAH, ATLANTA, KNOXVILLE, BIRMINGHAM, MEMPHIS, LITTLE ROCK, MUSKOGEE, TULSA, OKLAHOMA CITY, WICHITA, ST. LOUIS, KANSAS CITY, TERRE HAUTE, CINCINNATI, INDIANAPOLIS, DETROIT, CHICAGO, ROCKFORD, OSHKOSH, GRAND RAPIDS, DAVENPORT, DES MOINES, OMAHA, SIOUX CITY

FOUNDED BY R. T. CRANE, 1855

CRANE CO.

836 S. MICHIGAN AVE.

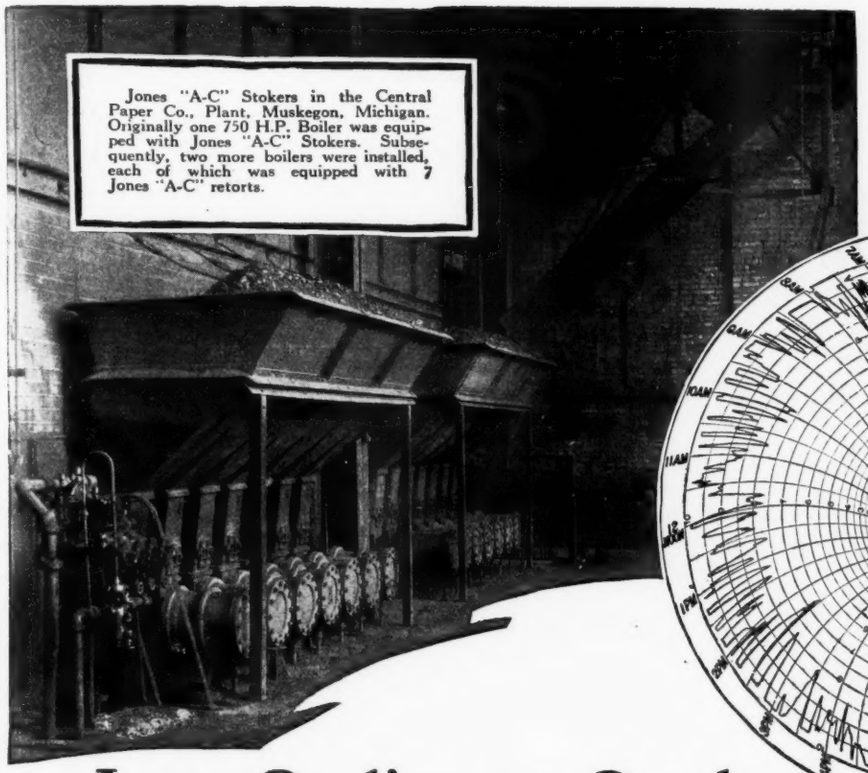
CHICAGO

WORKS: CHICAGO AND BRIDGEPORT

ST. PAUL, MINNEAPOLIS, WINONA, DULUTH, FARGO, WATERTOWN, ABERDEEN, GREAT FALLS, BILLINGS, SPOKANE, SEATTLE, TACOMA, PORTLAND, POCATELLO, SALT LAKE CITY, OGDEN, SACRAMENTO, OAKLAND, SAN FRANCISCO, LOS ANGELES

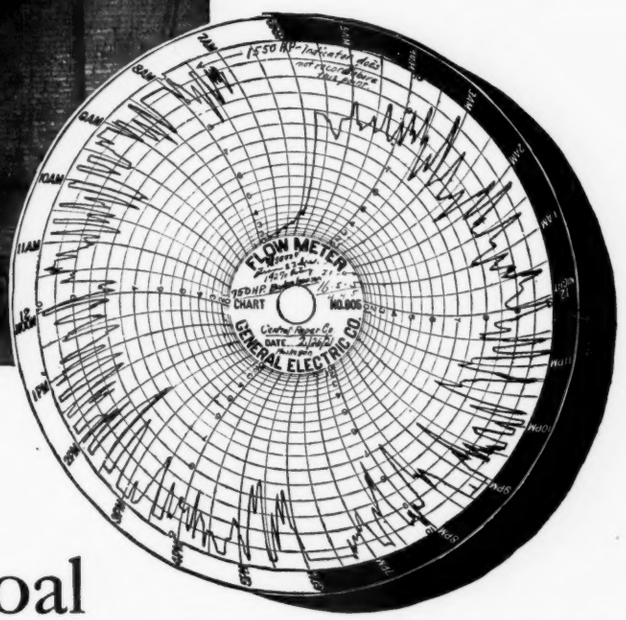
CRANE LIMITED — MONTREAL, TORONTO, VANCOUVER, WINNIPEG, LONDON, ENG., SYDNEY, N. S. W., QUEBEC, HALIFAX, OTTAWA, REGINA, CALGARY.

We are manufacturers of about 20,000 articles, including valves, pipe fittings and steam specialties, made of brass, iron, ferrosteel cast steel and forged steel, in all sizes, for all pressures and all purposes, and are distributors of pipe, heating and plumbing materials



Jones "A-C" Stokers in the Central Paper Co., Plant, Muskegon, Michigan. Originally one 750 H.P. Boiler was equipped with Jones "A-C" Stokers. Subsequently, two more boilers were installed, each of which was equipped with 7 Jones "A-C" retorts.

One Hundred and Ninety-Two Per Cent of Boiler Rating for 23 Hours. Peak Loads of 300% and Over.



Just Ordinary Coal —but *Extra*ordinary Service

That is the verdict of this flow meter chart — and the flow meter is the supreme court of the boiler room. The chart is typical of several charts made in the plant illustrated — in fact, is typical of the every day performance of most Jones equipped plants.

Note that the 750 H.P. boiler was operated at approximately 192% rating for 23 hours *continuously*. As the flat stretches in the curve indicate, the chart only records to 1550 H.P., and the boiler capacity was carried considerably over that figure several times for peak loads of 300% and over. These over-ratings were obtained with just a fair grade of coal!

It is not alone this exceptional performance that has led this and hundreds of other plants to repeatedly install Jones "A-C" (Automatic-Cleaning) Stokers, for although such performance would justify this, there is a still better reason for choosing the Jones "A-C":

—Because of its unequalled simplicity and rugged construction the Jones "A-C" will *continue* to meet heaviest overloads day in and day out without shutdowns with less attention, and with less repairs. Super-service constantly maintained is what enables the Jones "A-C" to *"Pay for itself—then pay dividends."*

Write for the new book, "Ten Points of Jones Superiority"—the story of supremacy in compact form.

The Under-Feed Stoker Co. of America

General Offices: Book Building, Detroit

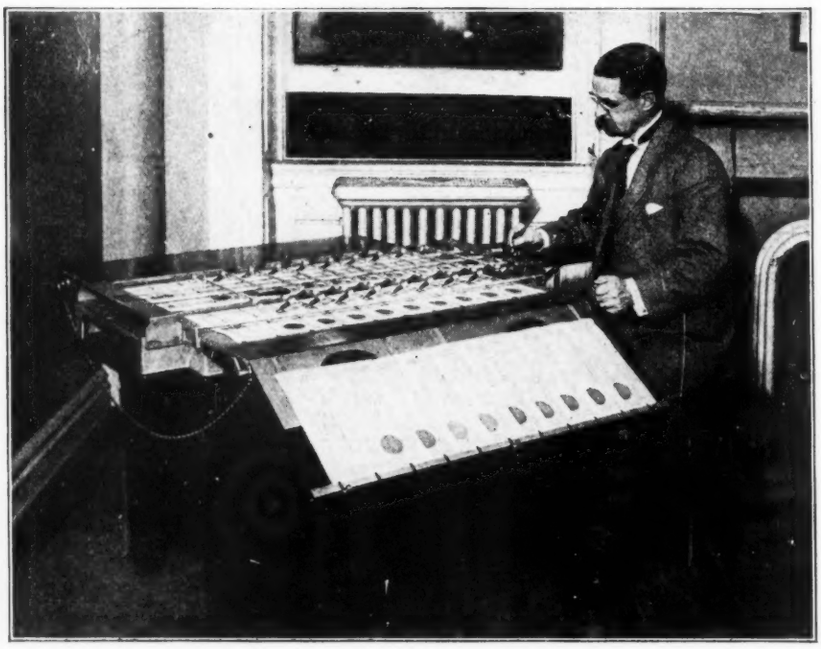
Boston	Chicago	Dallas	Minneapolis	Omaha	Salt Lake City
Buffalo	Cincinnati	Denver	New Orleans	Philadelphia	Seattle
Charlotte	Cleveland	Kansas City	New York	Pittsburgh	St. Louis

The Under-Feed Stoker Co., of Canada, Ltd., 81 Victoria Street, Toronto

Sole Manufacturers in the United States and Canada of the Jones Under-Feed Stoker

JONES "A-C" STOKERS

CAPA



With mechanical aid one man can sign a score or more certificates at a time.

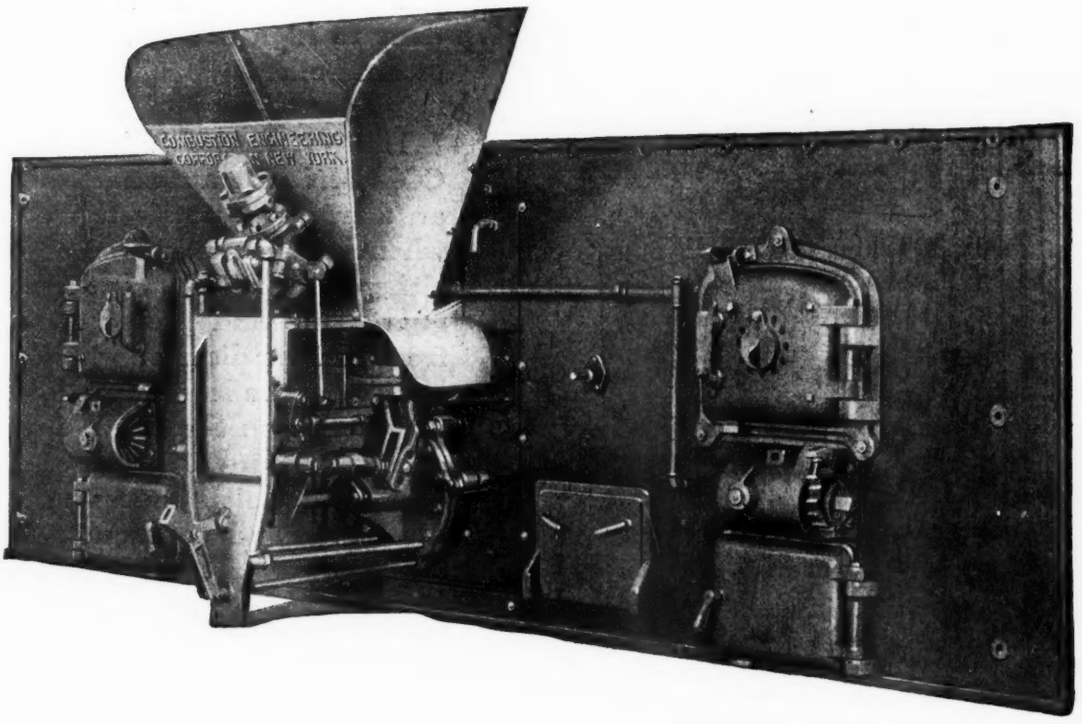
Economy
Capacity ✓
Simplicity
Ease of Operation
Ease of Installation

CITY

With the mechanical aid of

TYPE E STOKERS

one man can do in your power plant what ordinarily requires several men to do when the peak comes on



COMBUSTION ENGINEERING CORPORATION

Combustion Engineering Building, Broad St., New York City

Owners and Manufacturers of

Type E Stokers—for Bituminous Coal | Lopulco Pulverized Fuel Systems | The Grieve Grate—Hand-Firing

Coxe Stokers—Anthracite Coal and Coke Breeze

PHILADELPHIA, PA. PITTSBURGH, PA. MINNEAPOLIS, MINN. BIRMINGHAM, ALA.
HAZLETON, PA. BOSTON, MASS. CHICAGO, ILL. SALT LAKE CITY, UTAH ALBANY, N. Y.
DETROIT, MICH OMAHA, NEB. DENVER, COLO. MILWAUKEE, WIS. ATLANTA, GA.
TAYLOR ENGINEERING CO., VANCOUVER, B. C.

LUNKEN "Vigilant Water

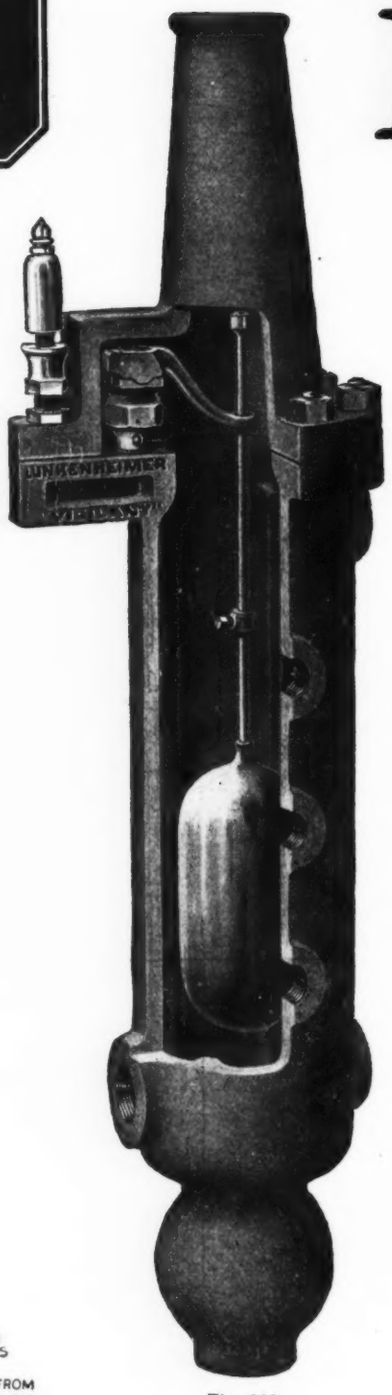


Fig. 919
"VIGILANT"
Safety Water Column

A *safety appliance* necessary for protection against the dangers incident to high and low water levels in steam boilers.

The "VIGILANT" SAFETY WATER COLUMN will automatically sound an alarm and notify the attendant whenever the water level approaches either danger limit. It thereby safeguards life and protects the boiler from serious disaster which may be caused by the low level allowing the fire to play on the crown sheets and tubes when unprotected, or extreme high level which causes priming of the boiler and consequent damage to the power unit and the connecting pipes and valves.

The action of the "VIGILANT" operating mechanism is simple but positive. The single float actuates the double acting valve through the medium of stops set for high and low level limits. When the water approaches either danger limit the valve is opened, permitting steam to pass and blow the signal whistle.

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OF CATALOG BEARS
No 58
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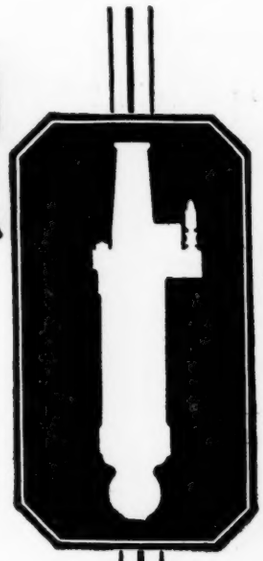
20-16-42

HEIMER "Safety Column



A sediment chamber is provided at the bottom to trap scale or dirt which may enter the Column; Gauge Cock connections are tapped on both sides to permit right or left hand assembly; the top is removable for inspection of working parts, and all parts are renewable.

The "VIGILANT" Safety Water Column is recommended for working steam pressures up to 250 pounds; is made in a variety of sizes to suit all makes of boilers, and from the extensive line of LUNKENHEIMER Water Gauges and Gauge Cocks available a combination can be selected to suit every individual installation.

Specify LUNKENHEIMER "VIGILANT" Safety Water Columns and insist on getting what you specify.

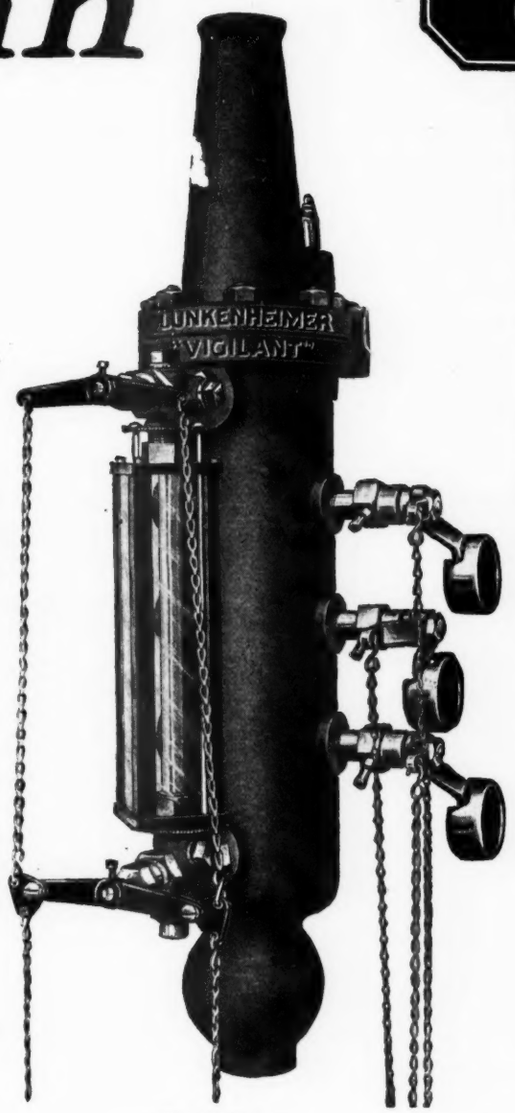


Fig. 1349 "VIGILANT" Safety Water Column equipped with Ex. Hy. Automatic Water Cauge with Glass Protector and and "Renewo" Gauge Cocks

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF HIGH GRADE ENGINEERING SPECIALTIES IN THE WORLD
NEW YORK CHICAGO CINCINNATI BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

AMERICA'S BEST
LUNKENHEIMER
QUALITY
SINCE 1862

METROPOLITAN INJECTORS

Depend on Them—

to feed the boiler at any time — under high or low steam pressure; with hot or cold feed water — steadily and faithfully.

— Years of injector building are back of the Metropolitan, the "know-how" of design, workmanship and materials.

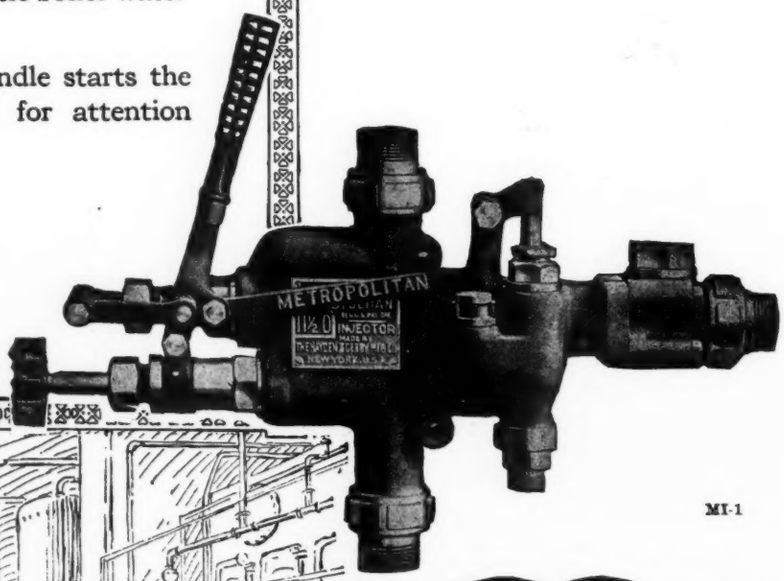
— Not manufactured merely to sell, but to fill the need for better, more reliable, "take-care-of-itself", automatic boiler water feeders.

— Simple; a turn of the handle starts the Metropolitan and all need for attention stops.

Depend on them

Engineers all over the world are doing so. Every worth while jobber stocks them— Metropolitans back up their judgment.

Depend on them



MI-1

METROPOLITAN INJECTORS are of a quality consistent with the high standards established by Manning, Maxwell & Moore Inc., for all products of their manufacture

MANNING, MAXWELL & MOORE INC.

HAYDEN AND DERBY WORKS

119 WEST 40TH STREET, NEW YORK, N.Y.

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VALVES · INJECTORS · INSPIRATORS · SAFETY VALVES · GAUGES · CRANES · MACHINE TOOLS · SUPPLIES

HANCOCK VALVES

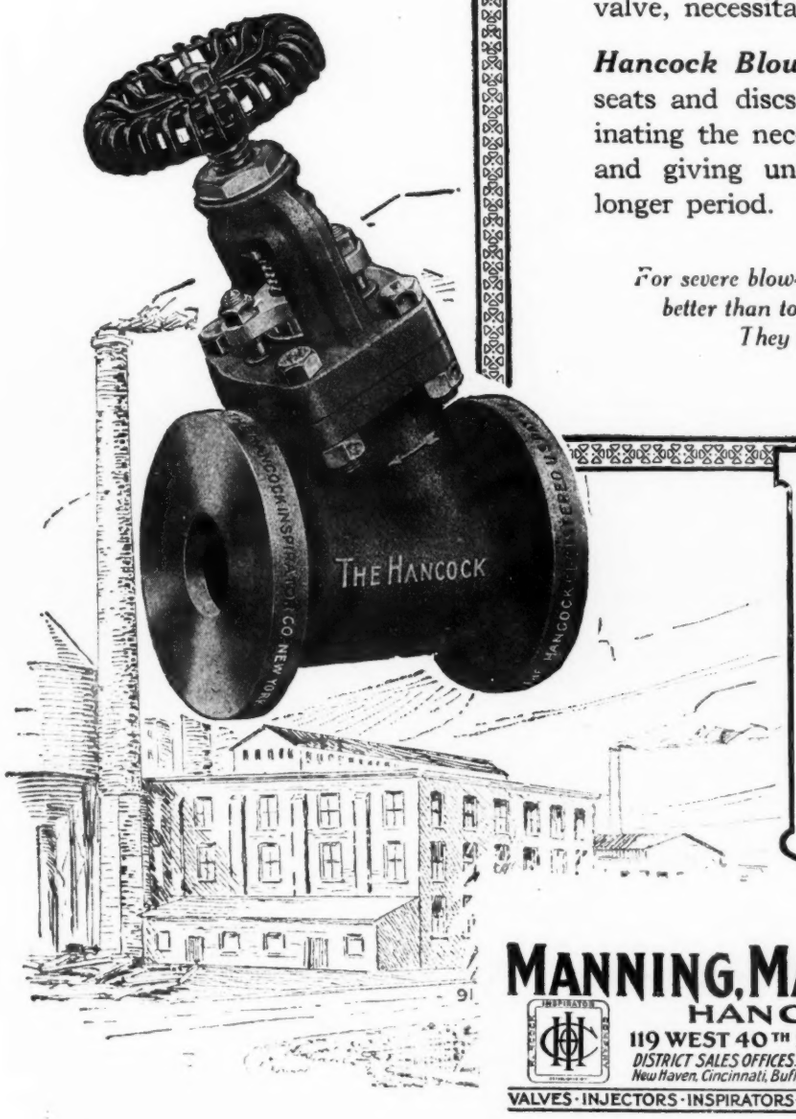
Masters of Superheat & High Pressure

—Incomparable for Blow-off Service

The abrasive action of scale and grit under the high pressure and velocity usually encountered in blow-off service in modern power plants, quickly cuts the seat and disc of the ordinary blow-off valve, necessitating frequent regrinding.

Hancock Blow-off Valves with nickel seats and discs resist this action, eliminating the necessity of constant repairs and giving unequalled service over a longer period.

For severe blow-off service—you cannot do better than to specify Hancock Valves. They are incomparable.



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HV-37

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VALVES · INJECTORS · INSPIRATORS · SAFETY VALVES · GAUGES · CRANES · MACHINE TOOLS · SUPPLIES

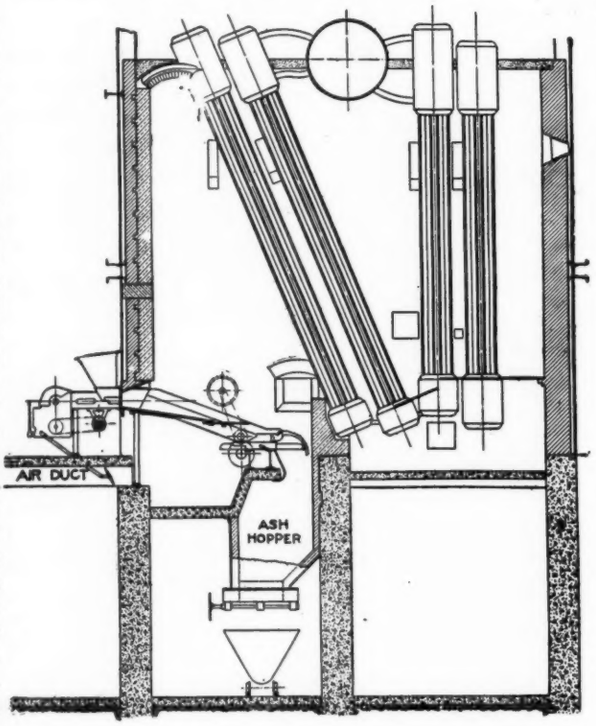
RILEY UNDERFEED STOKERS

INSTALLATION INFORMATION

Suggestions for the Installation of
RILEY Underfeed STOKERS under various types of boilers and to suit certain limiting conditions. (No. 5)

Enclosed Ash Alley

This shows a more or less ideal setting with ash hopper discharging downward. The ashes are confined to the passage shown, and are thus kept away from the fans and stoker drive shafting, which may be properly located either in basement or on boiler room floor. In this instance the stoker countershaft is suspended from drop hangers fastened to the stoker cylinders. This makes an excellent layout especially in conjunction with individual stoker drives. The arrangement of dropping the floor level under the stoker proper allows simple air ducts to discharge horizontally without any turns.



Catalog P-6 gladly sent on request.

The Sanford Riley Stoker Company is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus-Tiffany patents.

"A type to meet every stoker need"

SANFORD RILEY STOKER CO
WORCESTER, MASS.
Makers of
RILEY STOKERS
BOSTON NEW YORK CINCINNATI

PHILADELPHIA CHICAGO PITTSBURGH ST PAUL

MURPHY IRON WORKS
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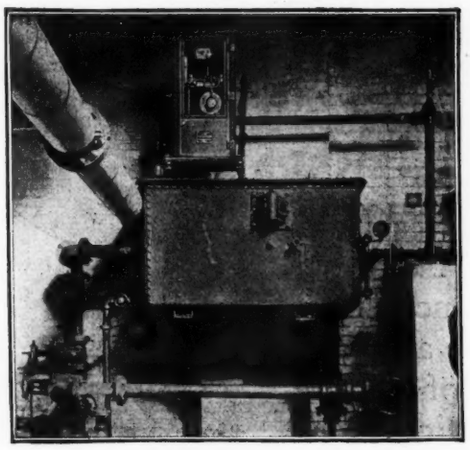
Makers of
MURPHY FURNACES
BUFFALO CLEVELAND DENVER

The YARWAY-LEA is the only genuine Lea Meter in the U. S.



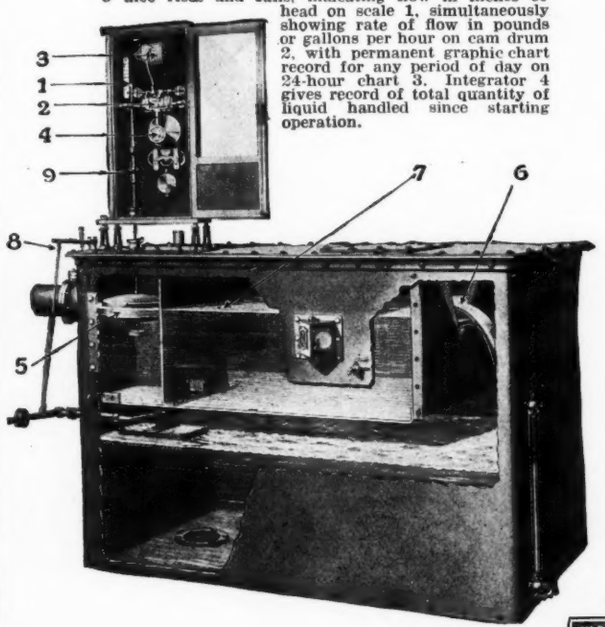
Yarway-Lea Meter at Rochester Last Works, Rochester, N. Y., measuring condensate returns from steam heating plant.

The first successful liquid recording meter using the V-Notch weir was the Lea Meter. It was invented and introduced in England in 1905 by James E. Lea, M. E. It is now favorably known to engineers in all parts of the world.

The Lea was also the pioneer in this country, where it took the lead in 1909. At that time the Yarnall-Waring Company secured—and still holds—exclusive rights of manufacture and sale on this side of the Atlantic.

International recognition — universal adoption—of any instrument is an unfailing barometer of its success. It is significant that since 1905, the year in which the Lea V-Notch Meter first came into commercial use, more than 2000 of the world's foremost concerns have installed this instrument as standard equipment. And it is well to remember that the *Yarway-Lea V-Notch Meter* is the only genuine Lea Meter made and sold in this country.

Operation: Liquid is admitted through control valve 8 to weir chamber 7. As liquid rises and falls, flowing through V-Notch 6, float 5 connected to rack rod 9 also rises and falls, indicating flow in inches of head on scale 1, simultaneously showing rate of flow in pounds or gallons per hour on cam drum 2, with permanent graphic chart record for any period of day on 24-hour chart 3. Integrator 4 gives record of total quantity of liquid handled since starting operation.



Bulletin L-40 will be sent on request.

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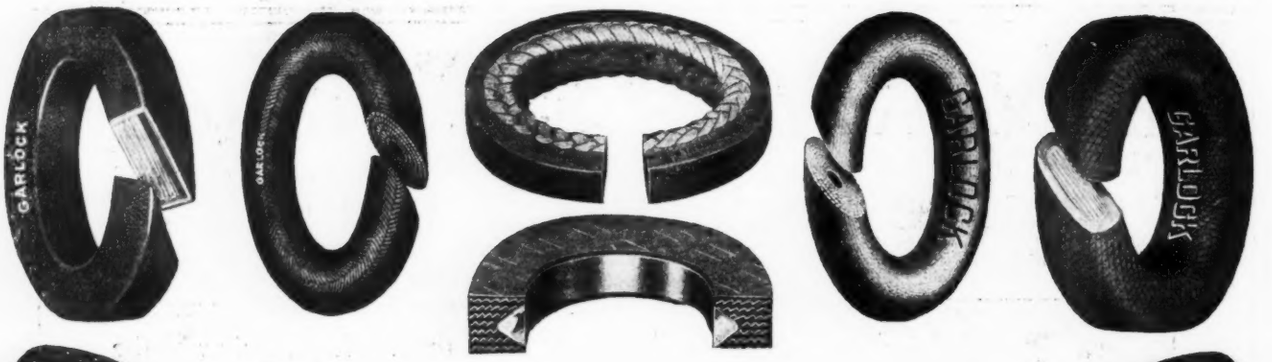
Representatives in all Principal Cities
For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE · YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE · YARWAY BOILER SKIMMER · YARWAY ADJUSTABLE SPRAY HEAD · YARWAY HYDRAULIC VALVE · YARWAY UNLOADER · YARWAY LEA V-NOTCH METER · YARWAY PIPE CLAMPS, ETC.

YARWAY
POWER PLANT DEVICES



Garlock Packings

HAVE you ever considered the loss in engine efficiency due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

A horse power easily can be absorbed at the stuffing box, and when considered in dollars and cents at the coal pile the loss would pay for a high class packing many times over.

Garlock packings are designed to meet every condition of service.

Write for catalog

The Garlock Packing Company
Palmyra, N. Y.

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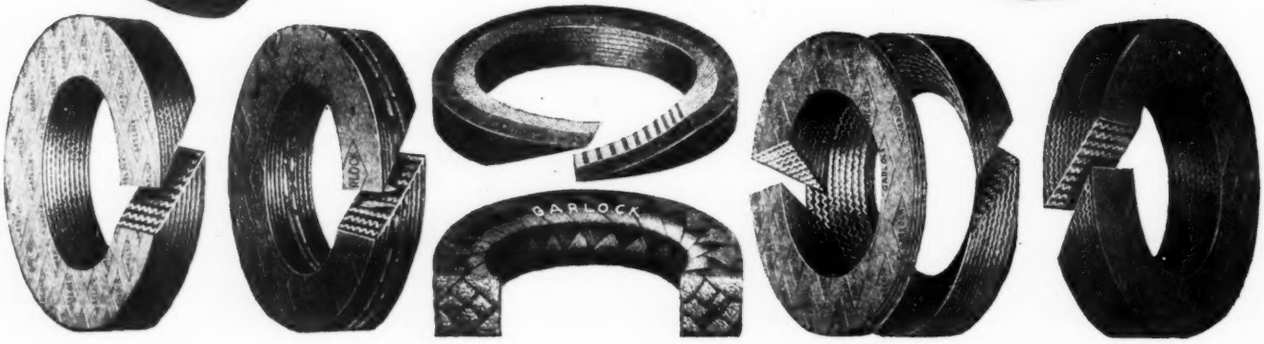
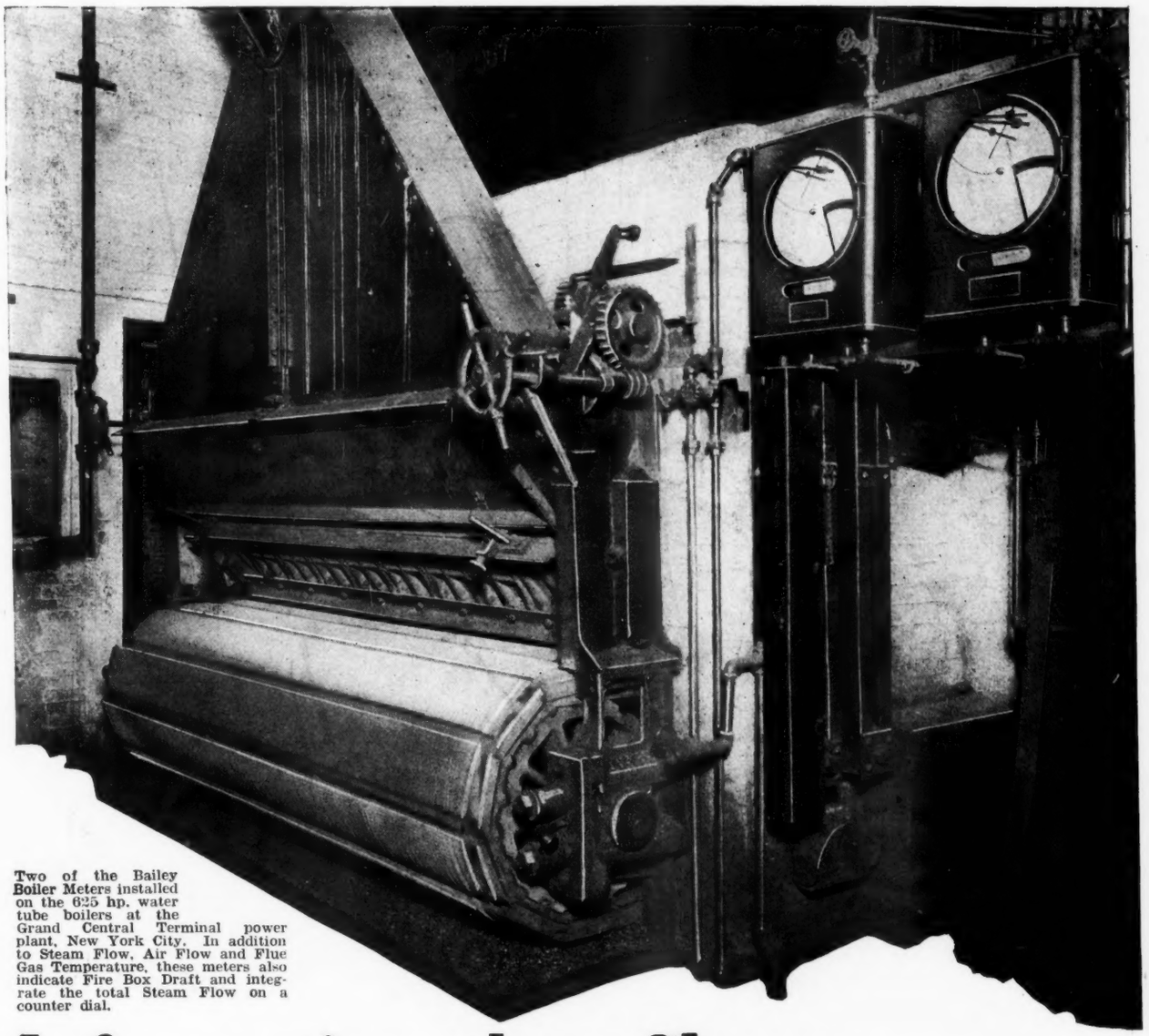




Two of the Bailey Boiler Meters installed on the 625 hp. water tube boilers at the Grand Central Terminal power plant, New York City. In addition to Steam Flow, Air Flow and Flue Gas Temperature, these meters also indicate Fire Box Draft and integrate the total Steam Flow on a counter dial.

Information that Shows How to Maintain Boiler Efficiency

It is given continuously to the firemen in a way that they can easily follow and cannot misunderstand by the chart records of

BAILEY BOILER METERS

These charts show Steam Flow in red, Air Flow in blue, and Flue Gas Temperature in green. When the fires are receiving the proper amount of air the Steam Flow and Air Flow records are merged into one. Any divergence from this condition calls for immediate attention. Thus more air must be admitted when the blue record is below the red. When the blue record is above, too much air is entering the furnace.

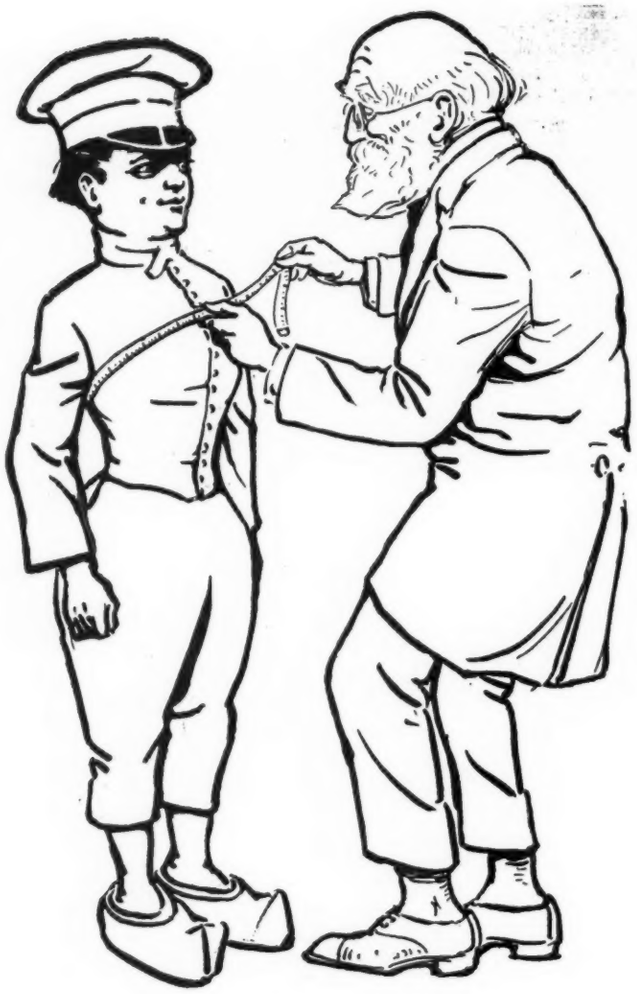
The records afford a daily check on boiler efficiency to the engineer in charge, keeping him in close touch with the work done by his men in the boiler room.

Consult us regarding the valuable additional information given by these charts.

Write us today for Bulletin.

Bailey Meter Co., 2011 E. 46th St., Cleveland, O.

Perolin
The Boiler
Metal Treatment



EXPANSION

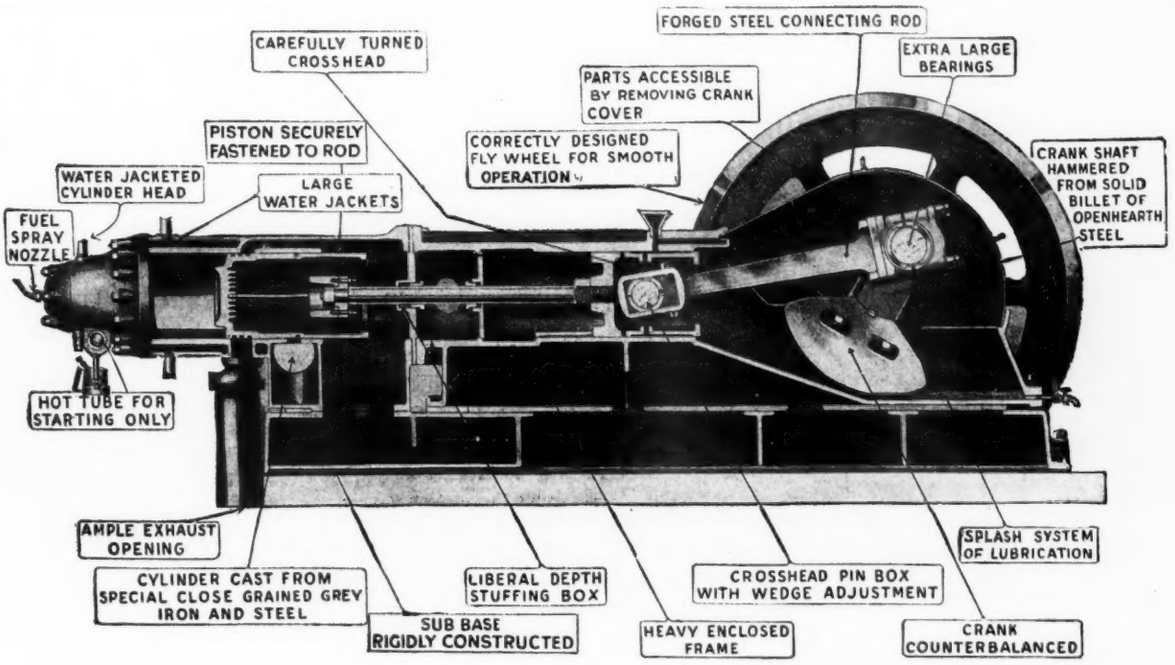
The natural expansion of matter with increase in temperature is enormously magnified in *Perolin—Boiler Metal Treatment.*

When fed into a steam boiler under pressure, in a small daily dose, it penetrates the existing scale, gets next to the hot metal, *expands* greatly and forces away the incrustation.

Send for booklet and learn how Perolin—Boiler Metal Treatment—prevents new scale from forming.

The Perolin Company of America

New York Woolworth Building — Toronto — London — Chicago Peoples Gas Building


FORGED STEEL CONNECTING ROD
CAREFULLY TURNED CROSSHEAD
EXTRA LARGE BEARINGS
PARTS ACCESSIBLE BY REMOVING CRANK COVER
PISTON SECURELY FASTENED TO ROD
CORRECTLY DESIGNED FLY WHEEL FOR SMOOTH OPERATION
CRANK SHAFT HAMMERED FROM SOLID BILLET OF OPENHEARTH STEEL
WATER JACKETED CYLINDER HEAD
LARGE WATER JACKETS
FUEL SPRAY NOZZLE
HOT TUBE FOR STARTING ONLY
AMPLE EXHAUST OPENING
SPLASH SYSTEM OF LUBRICATION
CYLINDER CAST FROM SPECIAL CLOSE GRAINED GREY IRON AND STEEL
LIBERAL DEPTH STUFFING BOX
CROSSHEAD PIN BOX WITH WEDGE ADJUSTMENT
SUB BASE RIGIDLY CONSTRUCTED
HEAVY ENCLOSED FRAME
CRANK COUNTERBALANCED

The inside construction of Giants will bear as close scrutiny as their outside reputation

USERS have learned from actual experience that Giant Semi-Diesel Oil Engines stand alone on the basis of ***dependability*** and operating economy.

And the attendants of these engines have learned that Giants, due to their rugged simplicity, are practically independent of the human factor.

Giant Oil Engines are preferred because they possess the greatest number of *advanced* features of construction. This statement is confirmed by their inside construction features illustrated above.

Each feature shown does a *necessary* job in delivering power at lowest possible costs, contributing to an indefinitely long service life, every-day dependability, and operating simplicity that lessens attendant costs.

On a basis of year-in and year-out worth, fuel economy, lowered upkeep and attendant costs—how much can Giants save in *your* plant? How soon could a Giant pay for itself? If you wish, a C-P sales engineer will help you find out.

Ask for Bulletin 389.

Chicago Pneumatic Tool Company

Chicago Pneumatic Building · 6 East 44th Street · New York

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EN 43

BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS.
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

CHICAGO CP PNEUMATIC

GIANT ENGINES

Dependable Power at Less Cost Per Hour

Getting Wasteless Combustion by a combination of McClave Grates or Stokers with Argand Blower

McClave GRATES STOKERS STEAM BLOWERS

IT is the waste in combustion which makes the fuel bill the biggest item in the operating costs of the boiler house.

It is not possible to utilize every bit of fuel heat. But in the average plant with old firing methods, wasted heat may be reduced from twenty to sixty per-cent with proper combustion.

Fuel economy may be further increased through the use of lower grades of coal. These grades sell for lower prices because few plants are equipped to burn them successfully.

But with the proper grates and adequate blast the very poorest grades may be substituted for the high grades previously used.

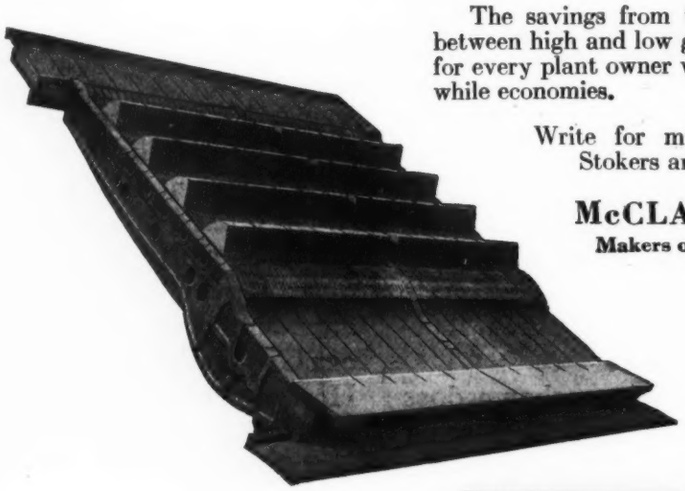
Nearly forty years of successful development are back of McClave Grates and Stokers. They are made in types adapted to the burning of all grades of coal.

In combination with Argand Blowers they will burn, successfully and economically, anthracite screenings, slack from bituminous coals and lignite, sweepings or coke breeze.

The savings from this single item of the difference in cost between high and low grades of coal, is a very substantial one for every plant owner who is seeking for a new avenue of worth while economies.

Write for more information about McClave Grates, Stokers and Argand Blowers.

McCLAVE-BROOKS COMPANY
Makers of the famous McClave Grates since 1883
SCRANTON, PA.



McCLAVE HAND-FIRED STOKERS
Showing full "kicker" movement (above) and partial "kicker" movement (below)

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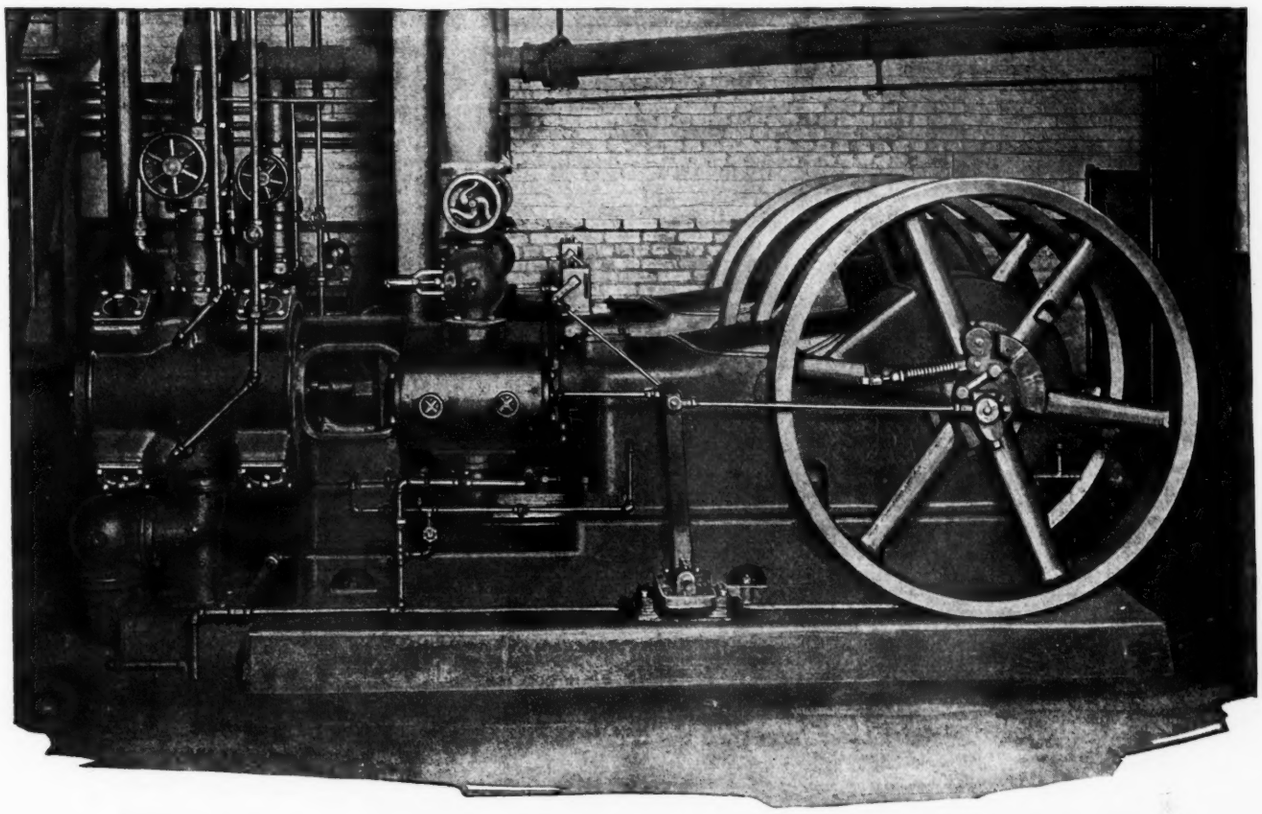
McClave COMBUSTION SYSTEMS *for greater economy*



"FR" COMPRESSOR FACTS

The balanced piston steam valve is especially designed for use with high steam pressures and superheat. Furthermore, it will operate equally well with saturated steam.

The automatic cut-off flywheel type governor maintains a constant compressor speed and automatically varies the position of the steam cut-off in accordance with air load. An intake unloader automatically regulates the amount of air compressed. Providing the compressor is to operate unloaded for a great part of the time a special throttling steam governor can be included to reduce the speed of the compressor during these unloaded periods.

These and other Ingersoll-Rand features make it possible for Class "FR" Compressors to operate with an unusually low steam consumption. In fact, a compressor equipped with ordinary flat steam valve and throttling governor requires approximately 50% more steam than is used by the same size Class "FR" machine.

PRICE FR OIL ENGINES

Bulletin No. 3131 describes the Class "FR."

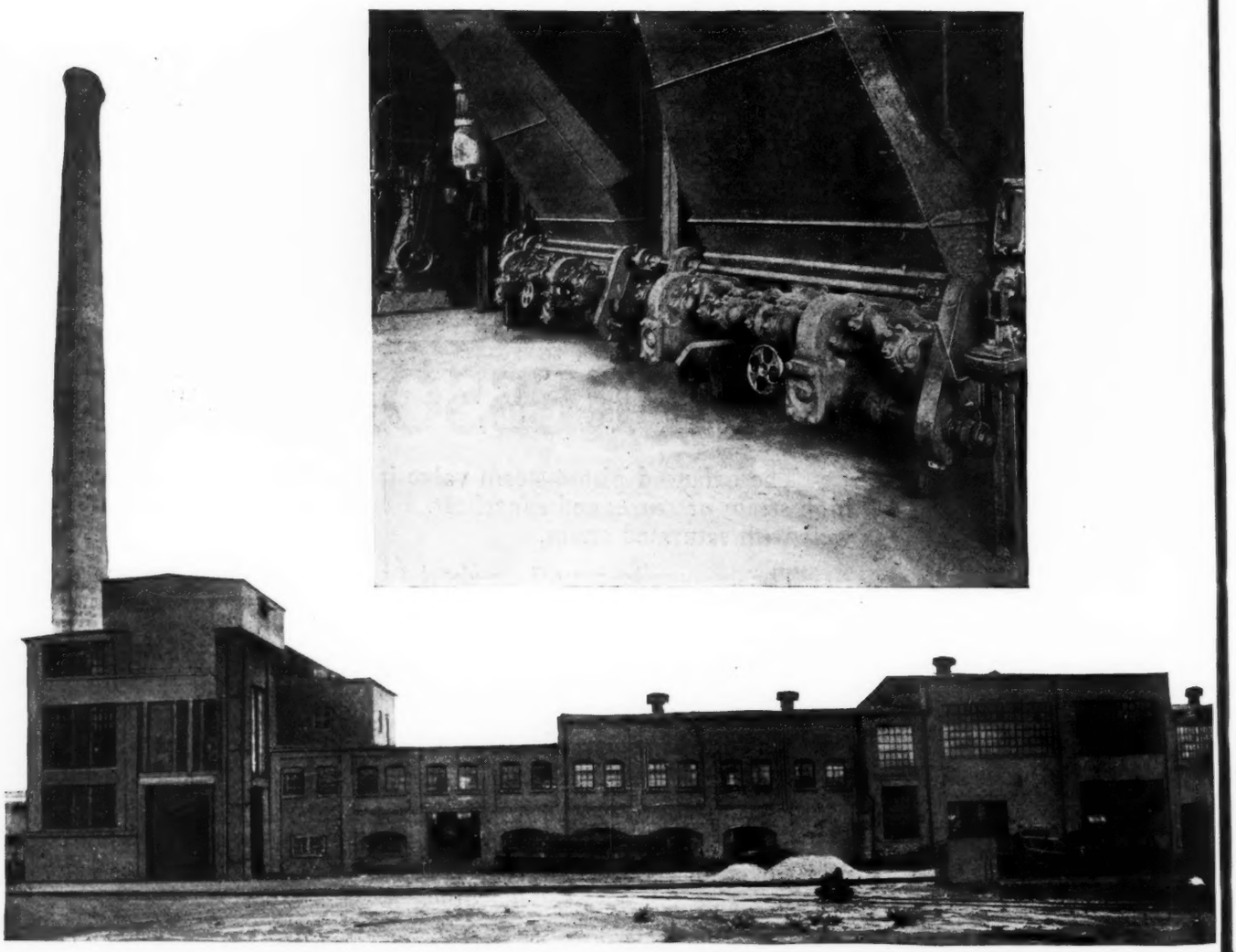
Ingersoll-Rand Company
11 Broadway, New York

535-C

Ingersoll-Rand

AE CO

"A. E. Co.



Why Clean Furnace by Hand?

When mechanical means have been devised for feeding and burning coal, why leave the hardest job of all to hand labor? The Taylor Power Dump effects efficient and complete ash discharge and clinker removal in 20 seconds, and the apparatus can be handled by a man of slight build. The Taylor Power Dump operates in three stages (1) Drop of dump plate allowing accumulation of ash and clinker to fall to pit, (2) Raising of plate above horizontal, breaking loose clinker on lower grates and tearing slag from bridge wall, (3) Second dropping of dump plate, letting these fresh loosened masses to fall to pit.

The Power-Dump, One of the Reasons for the Superiority of—

Renders Real Service"

The Chief Engineer of the American Shipbuilding Company, Lorain, Ohio, made this comment the other day. He meant it. He has had years of experience with Taylor Stokers and Taylor Service.

Other Taylor users will tell you the same thing. Ask them and see.

Here are some of the salient facts:

District erecting superintendent in each principal city, with a force of expert erecting and operating men. When a sale is made, these men erect the stokers and instruct the personnel of the plant in their operation. After that, the district force keeps constantly in touch with the customer.

Corps of travelling inspectors making periodic visits to all Taylor Stokered plants, to ascertain whether the original instructions are still being carried out or whether new conditions have arisen that demand new procedure and therefore new instructions. Our salesmen also make regular visits to the plants where they have made sales.

Each customer is furnished with specific information on spare parts with data for ordering each.

Orders routed immediately on arrival. In 40 per cent of cases shipment of spares is made on same day as received. In 90 per cent, orders are shipped within 3 days.

Service!

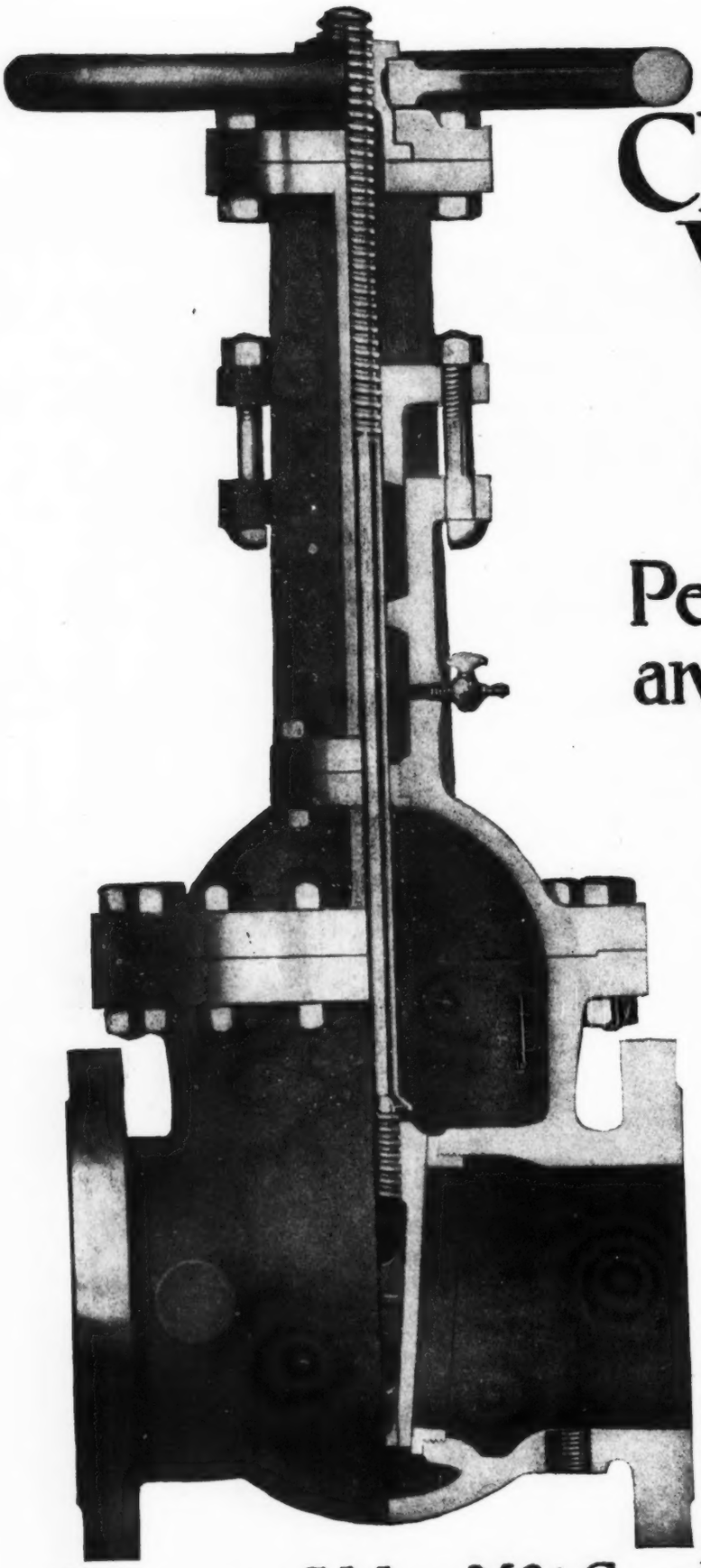
Which Book Do You Want?

"The Taylor Stoker and the Central Station" gives in brief form the remarkable results of Taylor installation in several representative central stations. "Are Mechanical Stokers a Good Investment?" tells what is being done by Taylors in representative industrial concerns. Ask for the booklet that applies to your field.

American Engineering Company
Philadelphia, Pa.

Manufactured in Canada by
Taylor Stoker Co., Ltd., Toronto, Ont.
Sales Office: 416 Phillipps Place, Montreal, Que.

The Taylor Stoker



Chapman Valves

Guaranteed Five Years

Performance and Reputation Count

The Chapman List 63½ Cast Steel Gate Valves are guaranteed for Five Years in Superheated Steam service.

This guaranty is not merely insurance—to protect you in case of failure; it is our ASSURANCE to you that the CHAPMAN VALVE WILL NOT FAIL.

This assurance comes not only from the design—providing for perfect distribution of stresses, etc.

It comes not only from the material—high elastic limit steel for bodies and caps; Monel Metal for spindles, spindle seats and seat rings to neutralize the wire drawing effect of superheated steam.

It comes not only from the workmanship—the highest type that can be produced by human or mechanical skill.

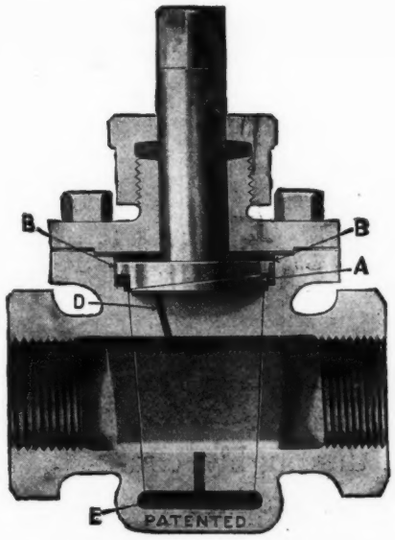
It DOES come from DESIGN plus MATERIAL plus WORKMANSHIP

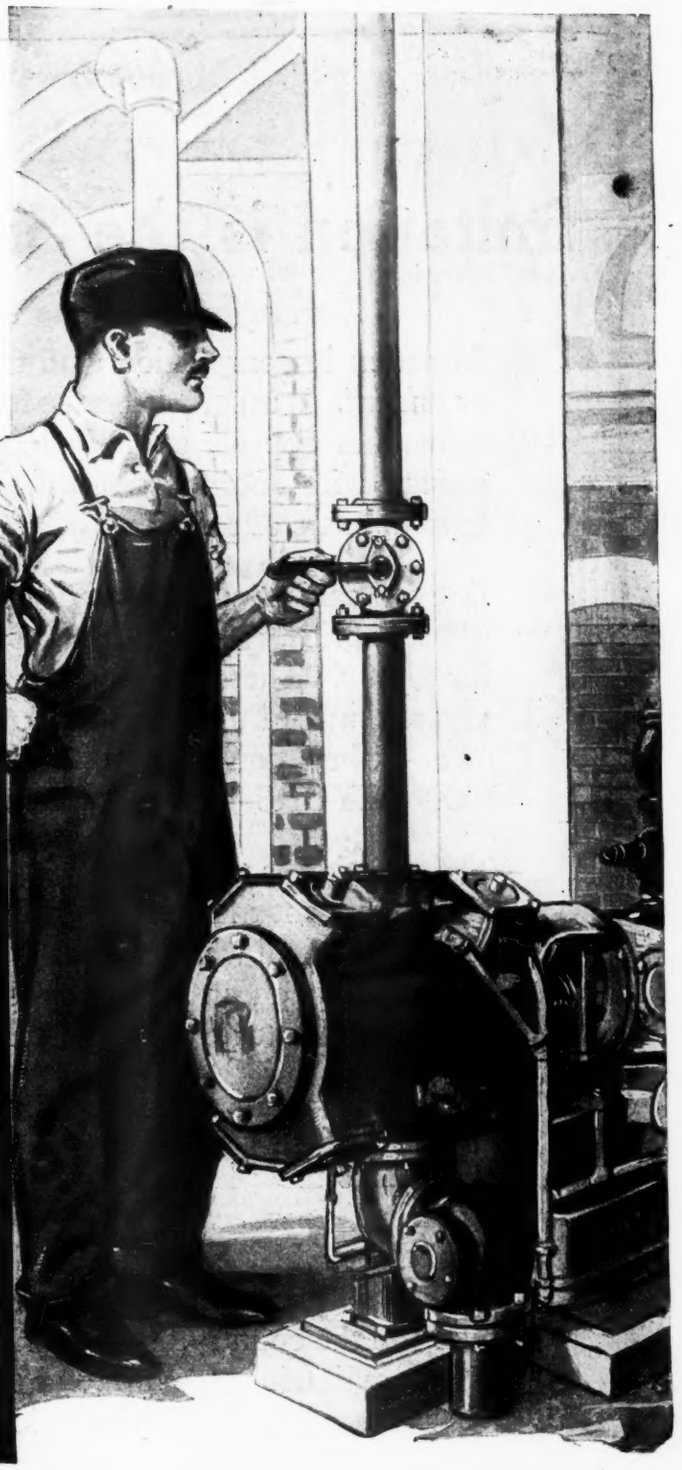
Ask for your copy of the Chapman Valve Handbook No. 38.

Branches:

New York, Boston, Philadelphia, Pittsburgh, Tulsa, Chicago, Detroit, San Francisco, Cleveland, Los Angeles

Chapman Valve Mfg. Co. ~ Indian Orchard Mass





Permanently Tight Under High Pressure and Temperature

Homestead Quarter Turn Valves have proved their absolute dependability on high pressure superheated steam lines. For this class of service they are made of a special bronze of high tensile strength and extreme durability under high temperature.

These plug valves afford a clear, unobstructed passage to the flow when open. Upon closing the plug is automatically forced downward by a patented traveling cam, which locks it in place. The slight wear is compensated for. The plug is always perfectly balanced and turns easily.

The seating surfaces are protected, while the pressure is passing through. No wire-drawing can occur.

Other Homestead Quarter Turn Valves are made of electric furnace semi-steel for every class of service for working pressures up to 5000 lb.

Let us solve your valve problem. Interesting Catalog mailed on request. Write.

Install a "Homestead" in place of your present faulty Globe and Gate Valves and watch results

Homestead Valve Mfg. Co.

134 6th Ave. Homestead, Pa.

New York Office:
242 Lafayette St., New York City

HOMESTEAD

QUARTER TURN VALVES

Imitation is the Sincerest Flattery

Imitation in competition with the original must have some argument. It usually takes the form of a lower price—which sometimes appeals strongly to those not thoroughly conversant with engineering skill, excellence of product and thoroughness of service.

But you can't buy a "champagne" steam jet ash conveyor at a "beer" price. The $75.00 suit of clothes can't be duplicated for $15.00. There are manufacturers of steam jet ash conveyors that will underbid us, but NOT on the same equipment — they don't make AMERICAN STEAM ASH CONVEYORS—and never can.

The question is this—shall we save a nimble nickel on the first investment and lose an honest dollar in conveyor life and upkeep, or shall we take arms against the hollow reasoning of the merely cheap and by opposing, end the discussion in favor of ultimate service and consequent ultimate saving.

We can prove our case—we want but the opportunity.

We make the plain statement ungarnished by frills of rhetoric that we can demonstrate that the AMERICAN STEAM ASH CONVEYOR is the most economical system yet devised for caring for the ashes from 75% of the plants in the country. The affirmative of the proposition is ours to maintain. It is up to us to furnish the evidence, and we have it ready. Will you look at it?

CONVEYORS CORPORATION OF AMERICA

Coal and Ash Handling Equipment

CHICAGO: 326 West Madison St. **NEW YORK: 110 West 40th St.**

COPYRIGHT 1918, BY AMERICAN STEAM CONVEYOR CORPORATION

The Valves that Safeguard "Life and Property"

Also made in plain non-return style for protecting the boilers only. Angle, globe and elbow pattern.

GOLDEN-ANDERSON

Patent Automatic Double-Cushioned Triple-Acting and Non-Return Valves

FEATURES:

1—Prevent complete shutdowns.
2—Work both ways. Automatically cut out a boiler if tube bursts and automatically shut off steam flow from every boiler when a steam pipe ruptures.
3—Automatically cut a boiler into the line, making accidents from improper gage readings impossible.
4—Absolutely prevent live steam from entering cold boiler, protecting men working inside.
5—Automatically equalize the pressure between all boilers.
6—Can be closed by hand like ordinary globe valve.
7—Can be closed automatically from distant points by steam or electricity.
8—Can be tested from boiler room floor.

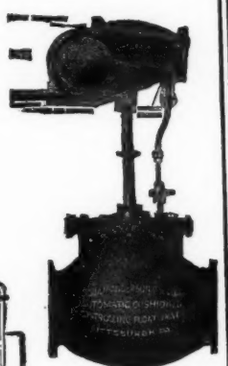
1997
Ordered by the U. S. Steel Corporation
after making thorough tests of all well-known makes

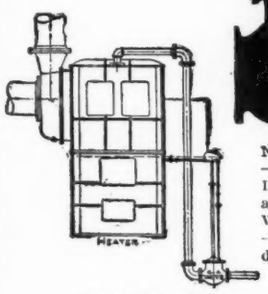
"THEY NEVER FAIL"
—to Prevent Shutdowns When a Tube Bursts

Golden-Anderson

Patent Automatic Cushioned Controlling Float Valves

Especially Adapted for Maintaining Uniform Water Level in Feed Water Heaters, Tanks, Reservoirs, Vats, etc.



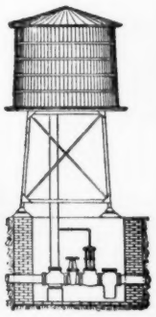


No Water Waste — Economic — Durable — Reliable — Air and Water Cushioned — Virtually Indestructible.

Feed Water Heater

Golden-Anderson

Patent Cushioned Automatic Controlling Altitude Valves



For Automatically Maintaining Uniform Stage of Water in Tank, Reservoir or Standpipes, Doing Away with the Annoyance of Floats or Fixtures, Inside or Outside. Especially Adapted for Water Works and Railroads. "Three Ways of Closing These Valves."

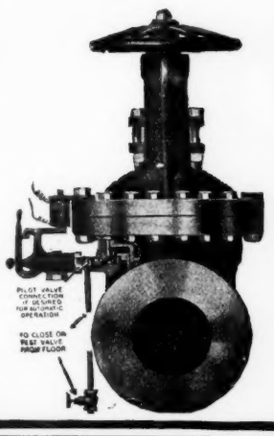
1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

Bar Disastrous Accidents from Runaway Engines with

GOLDEN-ANDERSON

Patent Cushioned Combined Throttle and Automatic Engine Stop Valves

1—Automatically tripped by overspeeding engine or turbine.
2—Electrically operated from distant points.
3—Emergency tripped by small branch pipe connection.
4—Hand operated by hand wheel.
5—Double cushioned by Corliss dashpots — positively no hammering or pounding.
6—Double extra heavy throughout — practically indestructible. Suitable for any pressure — no adjustments.



"Hosts of References"

GOLDEN-ANDERSON VALVE SPECIALTY CO.
1217 Fulton Bldg., ***Water and Steam Specialties*** **Pittsburgh, Pa.**

Monel metal in Power Plant Apparatus

These manufacturers use this metal for vital parts that must resist

GAUGES

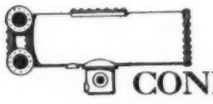
The Reliance Gauge Column Co.
The Foxboro Co., Inc.
Simplex Valve & Meter Co.

FANS AND BLOWERS

American Blower Co.
Buffalo Forge Co.
Garden City Fan Co.

GASKETS

U. S. Indestructible Gasket Co.
Akron Metallic Gasket Co.
Goetze Gasket & Packing Co.
The Gasket Supply Co.



CONDENSERS

Westinghouse Electric & Manufacturing Co.

GOVERNORS

Waters Governor Co.
The C. E. Squires Co.
Northern Equipment Co.
S. C. Regulator Co.
Fisher Governor Co.
Kieley & Mueller, Inc.

INSTRUMENTS

The Bristol Co.
Lewis M. Ellison
Schaeffer & Budenberg
Taylor Instrument Co.
Foxboro Co.
Brown Instrument Co.
Jos. W. Hays Corp.
American District Steam Co.

AUTOMATIC ENGINE STOPS

Jenkins Machine Co.

METERS

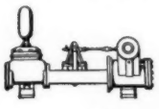
Bailey Meter Co.
Worthington Pump and Machinery Corp.
Pittsburgh Meter Co.
Equitable Meter Co.

SOOT BLOWERS

Everlasting Valve Co.
Vulcan Soot Cleaner Co.

PRESSURE REGULATORS

Mason Regulator Co.
National Regulator Co.
Foster Engineering Co.
Boylston Steam Specialties Co.
Equitable Meter Co.
Ford Regulator Corp.
S. C. Regulator Mfg. Co.
Julian D'Este
Northern Equipment Co.
Powers Regulator Co.
A. W. Cash.



PUMPS

The Viking Pump Co.
Blackmer Rotary Pump Co.
American Well Works
Worthington Pump and Machinery Corp.
Twinvolute Pump & Mfg. Co.
Chas. S. Lewis & Co.
Pennsylvania Pump & Compressor Co.
Manistee Iron Works Co.
Croll-Reynolds Co.
Buffalo Steam Pump Co.
Earle Gear & Machining Co.
M. T. Davidson

EJECTORS

Manning, Maxwell & Moore, Inc.

This is a partial list of manufacturers who insure the proper performance of their products by writing Monel metal into their specifications.

Monel is as strong as steel and has practically the same co-efficient of expansion. It is unaffected by alkalies and most acids and simply will not rust. There is no other metal possessing this balance of qualities. So more and more operators of power plants are substituting Monel parts in their old apparatus and insisting upon the use of Monel in all new equipment.

THE INTERNATIONAL NICKEL COMPANY

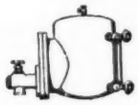
Producers of Metallic Nickel in the forms of Ingot, Shot, Electrolytic Cathodes—99 8/10% Malleable Nickel, Nickel Salts, Oxides, Carbonates, Sulphates, Sulphides, Acetates, Formates—Monel Metal, Ingot, Shot, Blocks.

67 Wall Street **New York City**

heat resisting metal wear and abrasion

DIESEL ENGINES

De La Vergne Machine Co.
Nordberg Mfg. Co
Busch-Sulzer Bros. Diesel Engine Co.

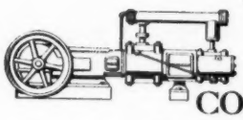


TRAPS

Wright Austin Company
Sarco Company
The Fisher Governor Co., Inc.
The C. E. Squires Co.
Templeton Mfg. Co.
Elliott Co.
Crane Co.
Nashua Machine Co.

VALVES

Jenkins Bros.
Henry Vogt Machine Co.
National Regulator Co.
Powell Valve Co.
Lagonda Mfg. Co.
The C. E. Squires Co.
The Fisher Governor Co., Inc.
Mason Regulator Co.
Consolidated Engine Stop Co.
G. M. Davis Regulator Co.
Foster Engineering Co.
Ford Regulator Co.
Schutte & Koerting
Ruggles-Klingemann Mfg. Co.
Pittsburgh Valve, Foundry & Construction Co.
The Lunkenheimer Co.
Pratt & Cady
Walworth Mfg. Co.
Edward Valve & Mfg. Co.
Star Brass Mfg. Co.
Manning, Maxwell & Moore, Inc.
A. W. Cadman Mfg. Co.
Everlasting Valve Co.
Kennedy Valve Mfg. Co.
J. E. Lonergan Co.
Powers Regulator Co.
Illinois Engineering Co.
Yarnall Waring Co.
Nelson Valve Co.
American Foundry & Construction Co.
Pittsburgh Reinforced Brazing & Machine Co.
Taylor Instrument Co.
National Valve & Mfg. Co.
Chicago Pneumatic Tool Co.
American District Steam Co.
Chapman Valve & Mfg. Co.



COMPRESSORS

Ingersoll-Rand Co.

EXHAUSTERS

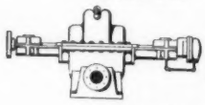
Schutte & Koerting

AIR SEPARATORS

Elliott Company

EXPANSION JOINTS

Crane Co.



TURBINES

Westinghouse Electric & Mfg. Co.
The Terry Steam Turbine Co.
Bethlehem Shipbuilding Corp.
DeLaval Steam Turbine Co.
The American Brass Co.
Ingersoll-Rand Co.
Rateau, Battu, Smoot Co.
B. F. Sturtevant Co.

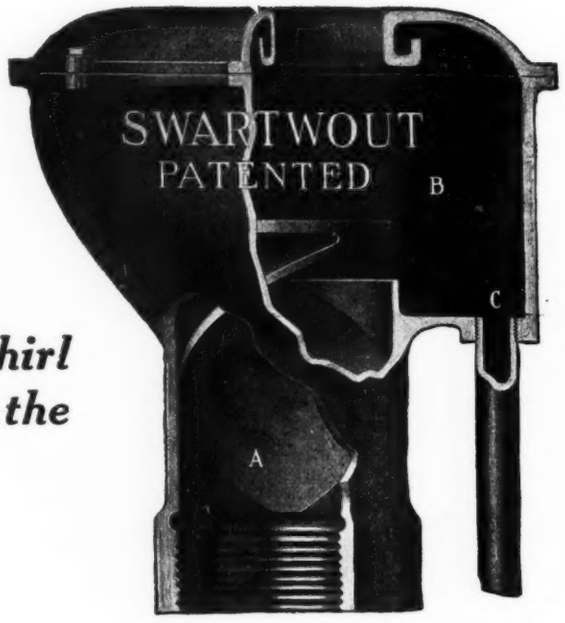
INCo MONEL METAL TRADE MARK

The name Monel identifies the natural nickel alloy—67% nickel, 28% copper and 5% other metals—produced by The International Nickel Company. Monel products include Monel blocks, Monel rods, Monel castings, Monel sheet, Monel wire, Monel strip stock, etc.

THE INTERNATIONAL NICKEL COMPANY

Producers of Metallic Nickel in the forms of Ingot, Shot, Electrolytic Cathodes—99 8/10% Malleable Nickel, Nickel Salts, Oxides, Carbonates, Sulphates, Sulphides, Acetates, Formates—Monel Metal, Ingot, Shot, Blocks.

67 Wall Street **New York City**



"It's the Whirl that does the trick"

REG. U.S. PAT. OFF.
Swartwout
The OHIO Body and Blower Co. Cleveland, U.S.A.

Roof Insurance

THE Swartwout Cast Iron Exhaust Head will protect your roof from the destructive effects of a constant rain of hot water and oil from your exhaust steam.

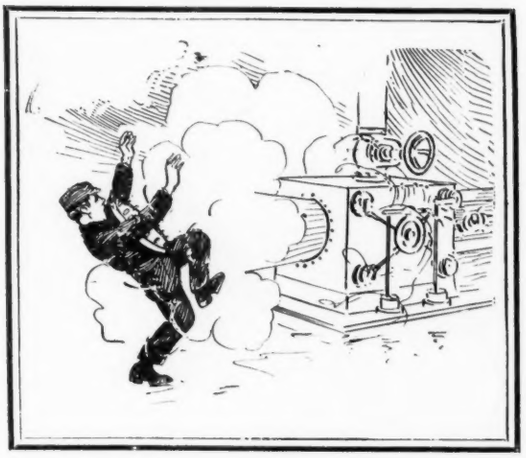
Swartwout Cast Iron Exhaust Heads will positively separate the oil and water from exhaust steam, so that nothing but dry steam escapes to the air. This is accomplished without the use of baffle plates or other obstructions which create back pressure. Comparatively light in weight, of pleasing design, and impervious to rust, Swartwout's will outlast the building on which they are placed.

Write for Bulletin containing full description of the Swartwout Exhaust Head and other Money Saving Steam Specialties.

SWARTWOUT SPECIALTY DIVISION OF THE OHIO BODY & BLOWER CO.
CLEVELAND

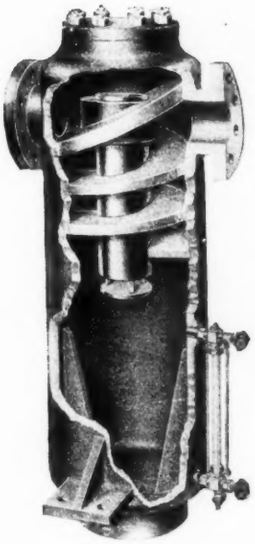
Swartwout
Industrial Specialties

Doesn't it Make Your Hair Stand on End?



To think that this accident may happen in your plant any minute. A

New Stratton Separator



will prevent it by removing all water from the steam before it enters the engine. Centrifugal force accomplishes the separation. No appreciable pressure loss.

Full information by return mail.
Send for Form Sheet 170.

THE GRISCOM-RUSSELL CO.
2116 West Street Building, New York City

Philadelphia	Pittsburgh	Minneapolis	New Orleans	San Francisco
Boston	Cleveland	Chicago	Houston	Seattle
Hartford	Toledo	Milwaukee	Fort Worth	Los Angeles
Springfield	Detroit	St. Louis	Charlotte	Kansas City

Don't Put Green Spectacles On Your Stokers

Remember the story of the man who put green spectacles on his cow? As far as economy went the idea was great—the shavings looked like fodder—but we all know what happened to the cow.

Some people think they can do about the same with stokers—feed them anything as long as it's black—and get good results. It can't be done!

Good coal crushed to proper size produces the highest operating and heating efficiency.

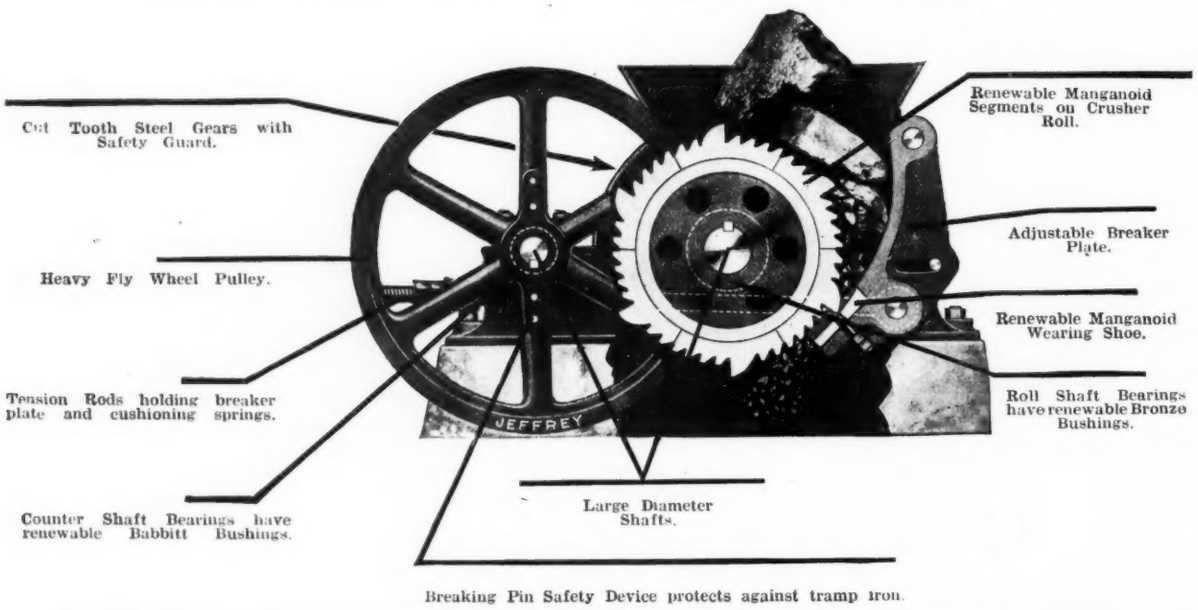
Jeffrey Single Roll Crushers are giving satisfactory results to hundreds of successfully operated power plants. This Crusher reduces lump or run-of-mine coal to stoker size in a single operation—uses little power—starts under full load and cannot be flooded or choked down—ruggedly built in four sizes and large capacities.

***If you will tell us your requirements,* our Engineering Department will be pleased to give complete details of this successful crusher.**

THE JEFFREY MFG. CO., Columbus, Ohio

BRANCH OFFICES:

New York	Scranton	Cleveland	St. Louis	Dallas	Los Angeles
Boston	Buffalo	Charleston, W. Va.	Detroit	Milwaukee	Middlesboro, Ky.
Philadelphia	Pittsburgh	Chicago	Birmingham	Denver	Montreal

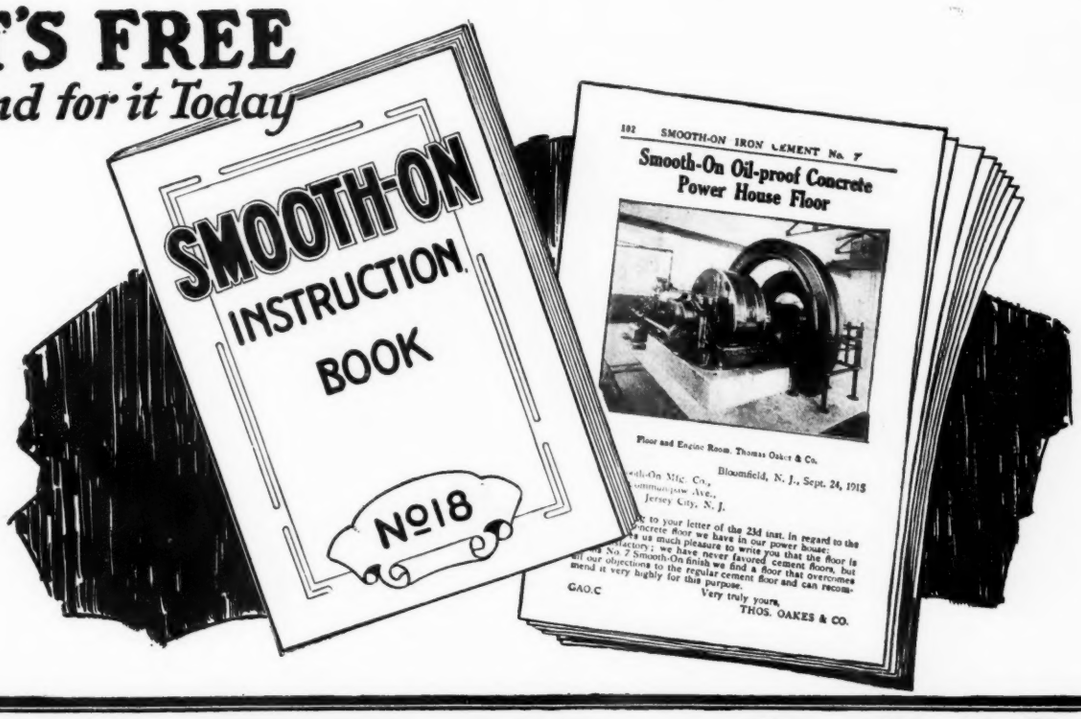

Cut Tooth Steel Gears with Safety Guard.
Heavy Fly Wheel Pulley.
Tension Rods holding breaker plate and cushioning springs.
Counter Shaft Bearings have renewable Babbitt Bushings.
Renewable Manganoid Segments on Crusher Roll.
Adjustable Breaker Plate.
Renewable Manganoid Wearing Shoe.
Roll Shaft Bearings have renewable Bronze Bushings.
Large Diameter Shafts.
JEFFREY

Breaking Pin Safety Device protects against tramp iron.

JEFFREY

Single Roll Coal Crusher

IT'S FREE
Send for it Today



SMOOTH-ON IRON CEMENTS

REG. U. S. PAT. OFF.

This Book is Ready for You

It's important to keep up-to-date in Smooth-On Iron Cement Instruction Books.

The latest one is No. 18 and it contains some interesting uses for Smooth-On Iron Cement that were not included in earlier editions.

Engineers are continually finding new uses in the way of boiler, engine room and general repair work and there is every reason why you should profit by their experience.

Send for Instruction Book No. 18 *now.*
You might forget if you put it off.

Wet Cellars

made dry from inside by coating the walls and floor with **Smooth-On** Iron Cement No. 7. Illustrated instruction book sent upon request.

292

Smooth-On Mfg. Co.
Est. 1895

570-574 Communipaw Avenue
JERSEY CITY, N. J., U. S. A.

CHICAGO OFFICE: 221 N. Jefferson St.
SAN FRANCISCO OFFICE: 56 Sacramento St.

Smooth-On Mfg. Co.
Jersey City, N. J.

Gentlemen: Kindly send me a free copy of Instruction Book No. 18 as per your June 28th advertisement in Power.

Name .....

Address .....

PUMPS

TRIPLEX • CENTRIFUGAL • ROTARY • DEEP WELL HAND

Acids, Barium, Lithophone, Zinc and Water are handled successfully in Collinsville Zinc Works by thirteen Goulds Pumps

Handling acids, barium, zinc and lithophone is a severe test for any pump, but the magnificent service rendered by the Goulds Pumps in the Zinc Works at Collinsville, Ill., is proof of the excellence of Goulds Pumps. There are twelve Goulds Centrifugals and one Deep Well Pump here operating against heads ranging from 10 ft. to 300 ft.—and every pump is very satisfactory. The maintenance costs have been hardly worth mentioning.

All Goulds Pumps are guaranteed to perform satisfactorily the specified work for which they are sold.

For severe pumping service use Goulds Pumps.

Let our engineers assist you on any pumping problem, and if you haven't a complete set of air Bulletins, drop us a line.

THE GOULDS MFG. CO.

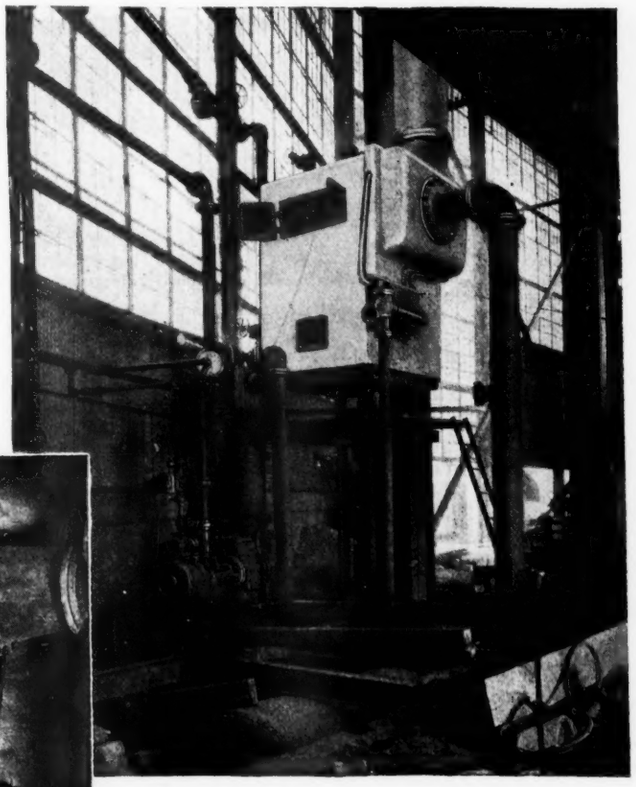
Main Works and Offices:

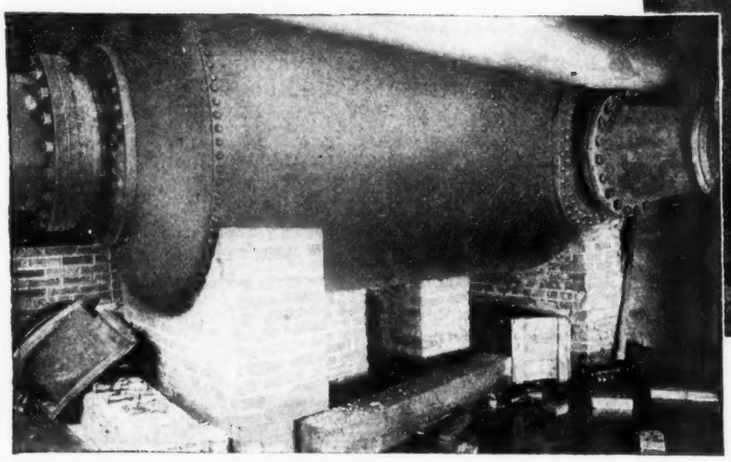
Seneca Falls, N. Y.

New York, 16 Murray St., and 19 Park Place. Boston, 58 Pearl St. Chicago, 12-14 S. Clinton St. Philadelphia, 111 N. 3rd St. Pittsburgh, 636 H. W. Oliver Bldg. Atlanta, Citizens' and Southern Bank Bldg. Detroit, 804 Dime Bank Bldg. Houston, 1001 Carter Bldg.

GOULDS

40 DAYS' COAL SUPPLY FREE





THE large Western forge plant in which the above photograph was taken is making effective provision against high coal prices. The best provision against high coal prices is the utilization of exhaust steam. Exhaust steam is equal in value to live steam for heating purposes, and where steam is required for heating, power can be obtained for next to nothing, since there is practically no fuel expense entering into its production.

In the plant where this photograph was taken the exhaust steam will be passed through a Cochrane Receiver Separator, just below the floor level in the foreground, before it passes to the heating system.

The saving from utilization of exhaust steam for heating ranges all the way up to 50%, depending upon the respective power and heating loads.

Part of the exhaust steam is also to be utilized in the Cochrane Heater to be seen in the picture. Using the exhaust steam to heat the feed water reduces the coal bill approximately one-seventh, in other words if a plant runs 300 days per year the heat recovered from exhaust steam replaces enough fuel to run the plant for over 40 days.

You may find some valuable suggestions on reducing your steam costs by reading our book on "The Profitable Utilization of Exhaust Steam," sent free upon request.

H.S.B.W.-COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

Manufacturers of the celebrated Cochrane Lines, including open feed water heaters, steam stack and cut-out valve heaters and receivers, metering heaters and independent meters, Sorge-Cochrane hot-process water softeners, steam and oil separators, and multiport back pressure, atmospheric relief, flow and check valves.

3136 North 17th Street **Philadelphia, Pa.** 126

Its Durability Makes It More Economical—

Your pump rods won't have to be repacked so often, if you use

"LION"
Hydraulic Packing

Made up with anti-friction metal studs, that are securely anchored in a flexible fiber body. Seals without binding or cutting. A rod preserver. Works automatically with the pressure.

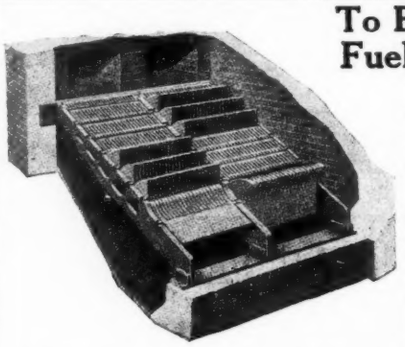
"LION" Automatic Hydraulic

Write for samples of both steam and hydraulic "LION" Packing.

Jas. Walker & Co., Ltd.
46 West St., New York City

AGENTS: J. & R. Wilson, Inc., San Francisco, Cal., Sole Agents; O. C. Keckley, 318 W. Washington St., Chicago, Ill.

To Economize Fuel—



Carry a uniform, free burning fire under every boiler. Make sure that the coal is burned at the highest efficiency by installing

Perfection Hand Stokers

Much heavier in design than other types. Ample provision for expansion and contraction. Abundant air space. Easily operated by outside levers. Write for Bulletin.

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—The Belt Preservative—

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Elevating, Conveying and Coal Rehandling Machinery

Put your problems up to the engineers of a company which has ranked high for over forty years.

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The Original
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F-4

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613

SEARCHLIGHT SECTION
Employment Equipment Business Opportunities

Advertisements for the

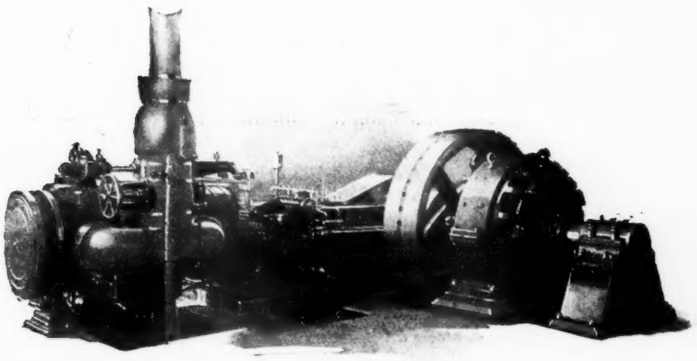
Searchlight Section

Can be received at the New York Office of Power until 10 a.m.

Wednesday

For issue of the following Tuesday

71



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It has replaced piston-valve, pressure-plate-valve and Corliss (both releasing- and non-releasing-gear) steam engines, steam turbines, oil engines and gas engines, and has made savings as great as 23½% in comparison with *other makes of unaflow engines!*

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Hochstadter Laboratories
Julian S. Simsohn
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Andrew Kidd, Jr.
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Process Oils for all manufacturing purposes
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CHIEF engineer wanted for steam electric plant 500 kw. capacity; Corliss engines. Must have record and produce results. State age, experience, salary expected and when available. P-734 Power, Old Colony Bldg., Chicago.

New York

ELECTRICAL foreman capable of handling men, industrial plant a.c.; 40 miles from New York; steady work, chance of advancement. State experience and salary expected. P-736, Power.

Pennsylvania

ENGINEER for design of steam turbine governors, etc., preferably located near Philadelphia. State qualifications, etc. P-737, Power, Real Estate Trust Bldg., Phila.

EMPLOYMENT SERVICE

EXECUTIVES qualified for salaries of $2,500 to $25,000 and upwards, are invited to communicate in strict confidence with the undersigned, who will conduct preliminary negotiations for such positions. The procedure used is peculiar to this service, differing essentially from all others, and is constructive and initiative; applied individually, and in no way jeopardizing present connections. Established 1910. Send name and address only for particulars. R. W. Bixby, Inc., 306 Lockwood Building, Buffalo, New York.

POSITIONS WANTED

Illinois

CHIEF engineer desires connection; 11 years' experience with first-class steam equipment; age 29, married. PW-738, Power, Old Colony Bldg., Chicago.

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ENGINEER, 17 years practical power plant operation, industrial electrical and mechanical engineering and maintenance, specializing combustion and practical plant organization. PW-718, Power, Old Colony Bldg., Chicago.

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EXECUTIVE position in manufacture of valves and fittings. I have been continuously employed for 30 years by four of the leading concerns in this line, beginning as apprentice toolmaker. During the past 17 years I have been engaged in executive capacities as department foreman, division superintendent and general works superintendent, having held the latter position during the last four years. My record is one of consecutive advancement during my industrial career. Will be open for engagement August 1. References to the above will be furnished anyone interested for the purpose of employment. PW-659, Power.

New Jersey

CHIEF engineer specializing in fuel and combustion engineering desires position with manufacturing organization; broad, practical and technical experience, stationary and marine, highest references. PW-743, Power.

New York

STEAM, electric engineer will be open for a position about Aug. 1st. He is a graduate of the International Correspondence Schools, and has had two years of practical experience as construction and maintenance superintendent in a million dollar power plant, with best of references. PW-735, Power.

Ohio

POWER and maintenance engineer with eight years' practical experience in plant maintenance, power plant operating, fixing and contruction, construction and design of industrial buildings, heating and ventilating systems, etc., desires position as maintenance engineer with steam power plant or firm of consulting engineers; good knowledge of fuel and construction engineering; executive ability; technical graduate. PW-725, Power, Leader-News Bldg., Cleveland.

Pennsylvania

A negro engineer, age 31, with 10 years' practice, and at present an I. C. S. student, wishes a position in a small steam plant; for past three years have been engineer in charge of a 5,000,000 gallon pumping station with three boilers and four pumps, and run night turn. PW-740, Power, Real Estate Trust Bldg., Phila.

POSITIONS WANTED

West Virginia

CHIEF electrician—14 years' maintenance, construction and operation, broad experience with frequency changers, rotary converters, motor-generators; transformers and winding. Construction of remote controlled switching equipment, testing and installation of switchboard instrument. Age 31; married; high school education. Available at once. Elwood Greene, Box 192, Mt. Hope, W. Va.

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Salesman

Actively visiting power plants in Middle West and Central States. Old, advertised, favorably known line; large commissions. AS-590, Power, Old Colony Bldg., Chicago.

Salesmen and Engineers

Sell our "Everlasting" Dead Plate for steam boilers. Lasts forever—25% commission. Write for proposition. Indestructible Dead Plate Co., 1031 N. Clark St., Chicago.

Salesman Wanted

Nationally known manufacturer of gasoline and oil storage equipment for factories, mills, railroads, etc., has valuable territory open for capable salesman. Personal acquaintance among industrial trade, and factory equipment sales experience, advantageous. State references, past experience. P. o. Box 1173, Milwaukee, Wis.

SALESMEN AVAILABLE

EASTERN territory wanted—Sales engineer representing large concern on industrial plant equipment in New England and Eastern States desires additional lines. AS-742, Power, Old Colony Bldg., Chicago.

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Coal Economy Service

Firms dealing directly with coal consumers, no matter where located, can add our "Service" to their line with profit; it also acts as a feeder to their own line. Any capable man with some knowledge of heating can make money with it. 25 per cent increase in heat from coal or 25 per cent saving of coal guaranteed. Endorsed by Tax Payers Associations and leading apartment house owners in New York City and elsewhere. BO-741, Power.

PATENT ATTORNEYS

PATENTS, C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventors' handbook sent upon request.

BOOKS AND PERIODICALS

Steam Users' Guide

Engineers and firemen send 15 cents in stamps for pamphlet of Stromberg's steam users' guide. Stromberg's Pub. Co., 260 Whiton St., Jersey City, N. J. 4658a Pope Ave., St. Louis, Mo.

OFFICIAL PROPOSALS

Bids: July 13.

Pumping Station Equipment

Reading, Pa.

Sealed proposals will be received by the Council of the City of Reading, Pennsylvania, until 8:30 a.m., Eastern Standard time, July 13, 1921, for the following items of equipment:

Item
1 Three 250 h.p. water tube boilers
2 Two 160-hp. water tube boilers and reconstruction of four existing boilers.
3 Three 250-hp. automatic chain grate stokers
4 Six 160-hp. automatic grate stokers
5 One 750-hp. feed water heater
6 One 800-G P.H. water purifier, with alternative proposition on one 2400-G.P.H. unit
7 Two 11,250-C.F.M. fans and engines, with alternative proposition on three 5,625-C.F.M. units
8 One radial brick chimney
9 Coal and ash handling equipment
10 One 15-M.G. turbo centrifugal pump, condenser and auxiliaries

Plans, specifications and bidding blanks can be had after June 28th, at the office of the Consulting Engineer, Louis T. Klauder, Pennsylvania Building, Philadelphia, Pa., or at the office of the Chief Engineer, Bureau of Water, Reading, Pa., upon deposit of five dollars.

Bidders must accompany their bids by cash, proposal bond or certified check for an amount equal to 10 per cent of the total amount of the bid.

A satisfactory bond will be required for the faithful performance of the contract, for an amount equal to one-half of the total amount bid.

In all the work herein embraced, preference shall, at all times, be given to local laborers and mechanics and the contractor must comply with the Workmen's Compensation Insurance Act.

Proposals must be made separately for each item, enclosed in separate envelopes with item marked thereon, and addressed or delivered to City Council, in care of Charles Marks, City Clerk, City Hall, Reading, Pa.

Council reserves the right to reject any or all bids, and to accept any bid which, in its judgment, is for the best interests of the City.

D. E. DAMPMAN,
Supt. Dept. of Parks and Public Property.
LOUIS T. KLAUDER,
Consulting Engineer.
EMIL L. NUEBLING,
Chief Engineer Bureau of Water.

Bids: Aug. 14.

Furnishing Material

STATE ELECTRICITY COMMISSIONERS OF VICTORIA
State of Victoria, Australia.

Tenders are hereby invited for the supply, delivery, etc., of the following plant for the Morwell Power Scheme:

Copies of the Tender Forms, Specifications, Drawings and Conditions may be inspected or obtained at the following offices of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, 734 Custom House, New York City, or 1424 First National Bank Building, Chicago, Illinois.

SPECIFICATION NO. 95

Section 1—Steel work for power station buildings.
Section 2—Roof covering, etc.

SPECIFICATION NO. 99

Section 1—Water tube boilers, stokers, fans, etc.
Section 2—Platforms and ladders.
Section 3—Steel chimneys, flues and dampers.
Section 4—Sooting and dust extraction equipment.
Section 5—Ash-handling plant.

Charges: $25 for the first three copies of each specification; for each subsequent copy with drawings, $7.50; for each subsequent copy without drawings, $5.

Tenders on prescribed forms properly endorsed will be received not later than noon on the 14th of August, 1921, by

R. LIDDELOW, Secretary.
State Electricity Commission of Victoria,
673 Bourke St., Melbourne,
Victoria, Australia.

The Commissioners do not bind themselves to accept the lowest or any tender.

P. S.—The State Electricity Commissioners of Victoria, Australia, have extended the date for receiving, at their office in Melbourne, tenders on Specification No. 99, water tube boilers and accessories, to noon on August 31, 1921.

U. S. GOVERNMENT

SEALED PROPOSALS indorsed "Proposals for Power Plant Improvements, Iona Island, N. Y., Specification No. 4215," will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 o'clock a.m., July 6, 1921, and then and there publicly opened, for power plant improvements, which consist of the provision and installation of foundations and brick settings for three 150 hp. return tubular boilers, 3 sets of furnace grates, certain breeching sections, air open type feed water heater, a float-controlled motor-driven pump, a twin filter, two traps, all accessories and complete piping systems for the new and the existing equipment; the removal of existing equipment, and the installation of three 150 hp. return tubular boilers, two boiler feed pumps, a damper regulator, a surface condenser, an air-separating tank, a circulating pump and a wet vacuum pump, furnished by the Government, in the power plant at the Naval Ammunition Depot, Iona Island, N. Y. Drawings and Specification No. 4215 may be obtained on application to the Bureau or to the Commandant, Third Naval District, 29th Street and Third Avenue, Brooklyn, N. Y. Deposit of a check or postal money order for $10, payable to the chief of the Bureau of Yards and Docks, is required as security for the safe return of the drawings and specifications. C. W. PARKS, Chief of Bureau, June 13, 1921.

U. S. GOVERNMENT

Bids: July 11.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., June 14, 1921.—Sealed proposals will be opened in this office at 3 p.m., July 11, 1921, for the mechanical equipment of the Junior Medical Officers' Quarters, at the United States Marine Hospital, New York, N. Y. (Stapleton), in accordance with drawings and specifications, copies of which may be obtained from the Supervising Chief Engineer, Room No. 731 United State Custom House, New York, N. Y., or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

Bids: July 6.

SEALED PROPOSALS indorsed "Proposals for Air Compressor, Charleston, D. C., Specification No. 4431," will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 o'clock a.m., July 6, 1921, and then and there publicly opened, for furnishing and supervising the installation of a 5,000 c.f.m. steam-driven reciprocating air compressor in the central power plant at the Navy Yard, Charleston, S. C. Specification No. 4431 may be obtained on application to the Bureau or to the Commandant, Navy Yard, Charleston, S. C. Deposit of a check or postal money order for $10, payable to the Chief of the Bureau of Yards and Docks, is required as security for the safe return of the specification. C. W. PARKS, Chief of Bureau, May 8, 1921.

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1—65 Kw., 250 V., 860 r.p.m., cp. wd., General Electric Generator, direct connected and mounted on common bedplate with one 220/440 V., 3 ph., 60 cy., new Allis Chalmers induction motor complete.

1—76 Kw., 125/250 V., 3 wire Western Electric motor generator set, consisting of Two 38 Kw., 125 V., Western Electric D.C. generators mounted on common shaft and belted to One new Allis Chalmers 220/440 V., 3 ph., 60 cy. induction motor, complete with switchboard.

1—150 Kw., 125/250 V., 1200 r.p.m., cp. wd., Westinghouse rotary converter, with transformers for 2200 V. high tension, 3 ph., 60 cy., 187 V., low tension with starting taps, complete with starting equipment and switchboard.

1—200 Kw., 250/275 V., 900 r.p.m., cp. wd., Ridgway generators direct connected and mounted on common base with One 2200 V., 3 ph., 60 cy., Ridgway synchronous motor, complete.

Write *Wire* *Phone*

DUQUESNE ELECTRIC & MANUFACTURING CO.
PITTSBURGH, PA.

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PORTABLE BOILERS

Marine type, self contained, 125-140 lb. Insurance Co. allowance. No patches, shaker grates, all regular fittings. Bargains.

General Equipment Co.
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Kewanee Boiler

complete, with stack, firing tool, damper, regulator, 100 W.P., 60 H.P., 6000 sq. ft. steam capacity, 9300 water capacity. Fire box 48 in. wide, 62 in. long, 49 in. high, with heating surface of 626 ft. Overall dimensions 60 in. x 13 ft. 3 in.

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BOILER WANTED

500 H.I. B. & W. Standard Type 180 lb. pressure. Send price, description, etc. to

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1—140-hp., Type "FH" De La Vergne Oil Engine, used only three months.
2—60-hp., Type "DH" De La Vergne Oil Engines, used about one year.
21 other Oil Engines, from 25 to 280 hp., in first-class operating condition.

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Prompt Deliveries

NEW AND REBUILT FULL DIESEL TYPE OIL ENGINES

2—450 b.hp. vert. 6 cyl. coupled to 3 ph. 60 cyc. a.c. generators.
1—450 b.hp., vert. 6 cyl. belted.
2—225 b.hp., vert. 3 cyl. bltd. or cpld.
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1—170 b.hp. vert. 3 cyl. belted.
1—120 b.hp. vert. 3 cyl. coupled to 85 kw. 3 ph. 60 cyc. 2300 volt genr.
1—120 b.hp. vert. 3 cyl. coupled or bltd.

SEMI-DIESEL OIL ENGINES

1—60 b.hp. vert. sgl. cyl. 2 cyc. bltd.
1—10 b.hp. vert. sgl. cyl. 2 cyc. bltd.
2—25 b.hp. horiz. F-M. type "Y" bltd.

GAS ENGINES

1—150 b.hp. vert. 3 cyl. coupled to 100 kw. 250 V. D.C. Genr.
1—100 b.hp. vert. 3 cyl. coupled to 62½ kw. 125-250 V. D.C. Genr.

Above only partial list—write or wire us full details your requirements.

A. McMILLAN
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Specialist in Diesel Oil and Internal Combustion Engineering

Boiler Equipment

FOR SALE AT A SACRIFICE

4—254-hp. B. & W. Class "A" Stirling Water Tube Boilers, complete with Combustion Engineering Corporation's Type "E" Stokers.

Recently overhauled: passed for 160 lb. Immediate shipment from Kenvil, N. J.

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Wilmington, Del.

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44—823 H.P. Sterling Boilers, Type M-30, 200 pound pressure. Equipped with Westinghouse 8 retort stokers, Vulcan soot cleaners, flow meters, 100,000 cu. ft. capacity, forced draft fan, direct connected to turbine. Practically new, at a bargain.

The Nashville Industrial Corporation
Old Hickory, Tenn.

Would YOU buy a SECOND-HAND ELECTRIC MOTOR at ANY price?
If you KNEW it to be as good as new?
Wire us your inquiries.

GREGORY ELECTRIC CO. CHICAGO, ILLINOIS
Second-hand Electric Motors Bought, Sold and Exchanged.
In business since 1893
16th and Lincoln Streets Chicago, Ill.

BARGAIN

1—625 Kva.

3 ph., 60 cy., 2200 v., 3600 r.p.m., Horizontal Westinghouse-Parsons Turbo Generator Set, complete with condenser, pumps and switchboard. Used two years.

Write—Wire—Phone

Duquesne Electric & Mfg. Co.
Bessemer Building, Pittsburgh, Pa.

Notice to Advertisers

Owing to the holiday, July 4th, the "Searchlight" pages of the July 5th issue will close for press earlier than usual. Copy should reach us by 5 p. m. Monday, June 27th.

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Performance Guarantee Backed by Surety Bond

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Used Motors, Renewed and Covered by Guarantee Backed by Surety Bond

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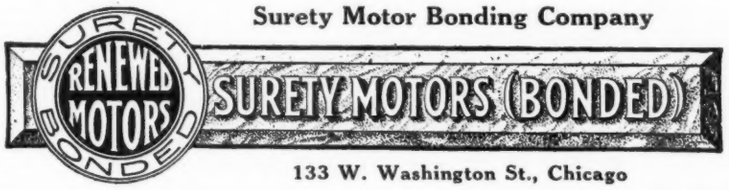
Miller-Seldon Electric Co.....1259 Park Place, W., Detroit
Willey-Wray Electric Co.....118 W. Third St., Cincinnati

The Surety Motor Bonding Co. establishes a system of rigid inspection and checking covering the renewing of used motors. Apparatus bearing the license label is guaranteed by the licensees. We guarantee their guarantee and cover it with a Surety Bond underwritten by one of the leading surety companies of the country.

Surety Motor Bonding Company



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Authorized General Electric Motor Dealers

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Send for Our Stock Lists of New and Used Motors

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14 x 7 x 12 in.	Knowles	500 gals.
18 x 10 x 12 in.	Worthington	1000 "
20 x 12 x 16 in.	Buffalo	1500 "

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Satisfaction Guaranteed or Money Refunded.

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Three 75 hp. Alberger

Producer Gas Engines

Each has two 14¼ x 16 single acting cylinders in tandem. One engine has Rites Automatic Governor and is built to belt from fly wheel. Two engines have variable speed throttling governors and are equipped with pulley and outboard bearing. Maximum Speed each engine 250 r.p.m. Engines are six years old but have been used very little. *Also* one 150 hp. **Syracuse Gas Producer** and one 250 hp. **Economic Gas Producer.** Both are complete with all necessary equipment for full operation.

The above apparatus may be seen in operation at our Plant.

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10—14-in. Worthington, Class B double suction 8,600 G.P.M. at 152 ft.
4—14-in. Allis-Chalmers Type S. 7,500 G.P.M. at 130 ft.
2—10-in. Allis-Chalmers Type S. 3,750 G.P.M. at 130 ft.
2—8-in. Allis-Chalmers Type S. 1,850 G.P.M. at 150 ft.
3—6-in. A. W. W. 1000 G.P.M. at 125 lbs.

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6—16-in. Allis-Chalmers Type S. 8,500 G.P.M. at 90 ft.
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STEAM DRIVEN HYDRAULIC

6—14 & 20 x 7½ x 18 Worthington Compound Duplex, 400 G.P.M. at 300 lbs.
10—25 & 38 x 4⅝ x 24 Worthington Tandem Duplex, 150 G.P.M. at 3,600 lbs.
2—20 x 12 x 16 Worthington Duplex Fire Pumps, 1,500 G.P.M.

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200—New and used Worthington Boiler Feed Pumps, various sizes.

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COMPLETE POWER PLANT

2—400 k.w. Direct Current Generators, Direct Connected to Heavy Duty, Rolling-mill type Corliss Engines.

Can be operated condensing or non-condensing. Capable of 100% overload. Also:

1—800 hp. Complete Boiler Plant, including all piping and fittings. Can be inspected erected in position. No Bricksetting required.

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1—60 hp. De La Vergne single cyl. **Oil Engine.**

1—110 volt, 60 cycle, 2 phase, General Electric **Generator.**

1—200 hp. De La Vergne, Double Cylinder **Oil Engine.**

1—220 volt, 60 cycle, 2 phase, Westinghouse **Generator.**

Complete with all parts for connecting and setting up. Can be seen at

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NEW 4000 KVA. 2300 V. WITH COND.
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1250 kva. 2300 v. hor. Non. Cond.
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14—26 x 42 Cross Compound Watts Campbell **Corliss Engine.**

Direct Connected **Aux. Lighting Sets, Marine** Type, 2½, 5, 8, 10, 20 and 25 kw. capacity.

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1—78 x 18 NEW H.R.T. Boiler, A.S.M.E., 150 lb. steam.

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Kw.	*Generator*	*Engine*
1250	Westinghouse	Turbine
625	Westinghouse	Turbine
500	General Electric	Skinner
500	General Electric	Allis-Corliss
475	General Electric	Uniflow
450	Allis-Chalmers	Vilter Corliss
375	General Electric	G. E. Turbine
360	General Electric	Harris Corliss
300	Allis-Chalmers	Skinner
300	Burke	Uniflow
300	Westinghouse	Ridgway
250	Allis-Chalmers	Allis-Chalmers
250	General Electric	McI. & S.
225	Westinghouse	Fleming, 4-valve
175	Allis-Chalmers	Allis-Chalmers
150	Allis-Chalmers	Ideal
125	General Electric	Erie Ball
120	General Electric	Hamilton Corliss
100	Crocker-Wheeler	Ridgway
90	General Electric	Uniflow
75	General Electric	Fleming
60	Electric Machinery	Skinner
50	General Electric	Harrisburg

230-250-VOLT D.C. UNITS

Kw.	*Generator*	*Engine*
425	General Electric	26 x 36 Corliss
400	Crocker-Wheeler	Bates Corliss
300	Crocker-Wheeler	Watt Campbell
300	Westinghouse	24 x 30 Corliss
250	Triumph, 3-wire	Skinner
225	Burke	32 x 30 Corliss
200	Westinghouse	Erie Ball
185	General Electric	Chandler Taylor
150	Westghse., 3-wire	Vertical comp.
150	General Electric	Turbine
100	Allis-Chalmers	Skinner
75	General Electric	Skinner
75	Westinghouse	Westghse, vertical
75	Allis-Chalmers	Erie Ball
62½	General Electric	Ames
35	Gen. Elec., 3-wire	Harrisburg
25	Gen. Elec., 3-wire	Troy, vertical

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Kw.	*Generator*	*Engine*
300	General Electric	Fleming, 4-valve
250	General Electric	Fleming, 4-valve
200	General Electric	Fleming, 4-valve
150	General Electric	Turbine
100	Westinghouse	Skinner
75	Crocker-Wheeler	Ames
75	General Electric	Harrisburg
65	Burke	Harrisburg
60	General Electric	Harrisburg
50	General Electric	Harrisburg
50	Westinghouse	Skinner
30	General Electric	Gen. Elec., Marine
30	General Electric	Ames
20	Burke	Chandler Taylor
20	Akron	Harrisburg
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1	350	2200/440	600	3	60	G. E. syn. motor or condenser
2	200	220/440	900	3	60	General Electric, form L
2	150	220/440	900	3	60	General Electric, form L
1	150	2200	900	3	60	G. E. syn. motor
2	100	220/440	720	3	60	General Electric, squirrel cage
3	75	220/440	900	3	60	Allis-Chalmers, slip ring
3	75	220/440	720	3	60	General Electric, squirrel cage
1	60	220/440	300	3	60	Westinghouse, slip ring
1	60	2200	900	3	60	Westinghouse, squirrel cage
2	50	220/440	900	3	60	Westinghouse, squirrel cage
1	50	2200/440	750	3	60	Crocker-Wheeler, squirrel cage
1	35	220/440	900	3	60	Westinghouse, squirrel cage
1	25	220/440	1200	3	60	Westinghouse squir. cage
1	15	220/440	1200	3	60	Westinghouse squir. cage
1	10	220/440	1800	3	60	Westinghouse
1	7½	220/440	1800	3	60	General Electri
1	5	220/440	1800	3	60	General lectric
1	2	220/440	1800	3	60	General jectric

SMALLER MOTORS ON REQUEST

D. C. MOTORS

1	350	250	480	DC	Westinghouse
1	275	250	500	DC	Westinghouse
1	100	800	250	CL	General Electric
1	75	500	575	DC	General Electric, CL
4	50	250	1250	DC	Shunt wound
1	40	250	875	DC	Westinghouse
1	35	230	750/1500		Allis-Chalmers
4	25	250	775	DC	Allis-Chalmers
3	25	500	600/1200		Allis-Chalmers
4	25	250	600/1200		Allis-Chalmers
2	20	250	810	DC	Allis-Chalmers
4	20	125	650	DC	Shunt wound
4	15	250	800	DC	Allis-Chalmers
1	15	250	1250	DC	Allis-Chalmers
1	10	250	1200	DC	Allis-Chalmers
4	10	250	275/1575	DC	Variable speed
1	7½	125	1100	DC	General Electric
1	5	125	700	DC	Diehl
1	3	125	1100	DC	General Electric

A. C. GENERATORS

1	300	220/440	900	3	60	General Electric
1	250	220/440	600	3	40	General Electric
1	200	2300	600	3	60	General Electric
1	200	220/440	600	3	60	General Electric
1	175	220/440	375	3	25	General Electric
1	100	900	2300	3	60	General Electric

D. C. GENERATORS

1	250	250	590	DC	Westinghouse
1	200	250	575	DC	Westinghouse
2	125	125	280	DC	Westinghouse
1	100	125	290	DC	Westinghouse
1	75	900	250	CL	General Electric
1	35	250	1000	DC	Westinghouse
2	15	125	800	DC	Shunt wound
2	15	250	900	DC	Allis-Chalmers

MOTOR GENERATOR SETS

1—200-kw., 600-r.p.m., 250-volt Westinghouse Generator, 350-hp. 600-r.p.m., 440/2300-volt synchronous motor.

1—125-kw., 600-r.p.m., 125/250-volt, 3-wire Westinghouse Generator, 190-hp., 600-r.p.m., 220/440-volt, squirrel cage motor.

1—100-kw., 250-volt, 1200-r.p.m. Westinghouse, direct connected, mounted on same base with 150-hp., 2200/440-v., 3-ph., 60-cy. synchronous motors.

1—75kw. 250-volt General Electric type CL, direct connected to

1—125 hp., 900 r.p.m., 3 phase, 60 cycle, 2200 v. General Electric synchronous motor

10—15 and 20-kw., 125-volt Balancer Sets.
Smaller sets upon request.

ENGINE GENERATOR SETS—D. C. SETS

1—100-kw. Westinghouse, 125-volt, with 15 x 14 simple Skinner engine, at 290 r.p.m.

2—125-kw. Westinghouse, 125-volt Generators, with 2—16 x 16 simple Harrisburg engines, at 280 r.p.m.

1—120-kw. Westinghouse, 125-volt Generator, with 15 x 15 Straight Line engines at 260 r.p.m

A. C. SETS

1—200-kva. Crocker-Wheeler, 3-phase, 60-cycle, 220 or 440-volt Generator, with 14½ x 23 x 16 Ames tandem compound engine, speed 200 r.p.m., with belted exciter.

1—225-kva. Crocker-Wheeler, 3-phase, 60-cycle, 220/440- or 2300-volt Generator, with 18 x 16 simple Ames (135 lb. steam), speed 200 r.p.m., with belted exciter.

1—Dean of Holyoke Duplex Jet Condenser for 500-hp. engine.
1—Bulkley Duplex Jet Condenser and all equipment for 300-hp. engine.

Power Plant Equipment

DIRECT CONNECTED UNITS

1—1800 hp. Cooper cross-compound engine, size 28 x 60 x 60, speed 80 r.p.m., flywheel 18 ft. 60 ton, direct connected to 1200 kw. G. E. 575 volt generator, 16 pole.

1—1800 hp. Cooper cross-compound engine, size 28 x 60 x 60, speed 80 r.p.m. fly wheel 18 ft. 60 ton, direct connected to 1200 kw. G. E. generator, 16 pole, 575 volt.

2—300 hp. Slater cross-compound engines, size 14 x 28 x 36, speed 120 r.p.m., direct connected to two 250-kw. 550 volt Westinghouse 8 pole direct current generators.

2—300 hp. McIntosh & Seymour tandem-compound engines, size 13 x 23 x 22, speed 200 r.p.m., fly wheel 4 ton, 9 ft. diameter, direct connected to two 220 k.w. Walker generators, 550 volt, 8 pole.

1—500 hp. Hamilton-Corliss Simple engine, size 28 x 36, speed 120 r.p.m. 18 ton, 14 ft. 6 in. fly wheel, direct connected to 400 kw. G.E. 550 volt, 8 pole, direct current generator.

2—1500 hp. Pennsylvania Iron Works, cross-compound engines, size 30 x 48 x 48, speed 80 r.p.m., fly wheel 22 ft., 50 ton, direct connected to 850 kw. G. E. 575 volt, 12 pole direct current generator.

1—750 hp. Greene cross-compound engine, size 20 x 38 x 48, speed 100 r.p.m., direct connected to 525 kw. G. E. 550 volt, 8 pole direct current generator.

1—700 hp. Pennsylvania Iron Works cross-compound engine, size 22 x 40 x 42, speed 90 r.p.m., direct connected to 500 kw. G. E. 550 volt, 10 pole direct current generator.

1—400 hp. Hamilton-Corliss cross-compound engine, size 16 x 30 x 42, speed 100 r.p.m., direct connected to 325 kw. Westinghouse 600 volt, 8 pole, direct current generator.

BOILERS

3—231 hp. B. & W. water tube boilers, 108-4 in. x 18 ft. tubes.

1—250 hp. B. & W. water tube boilers, 126-4 in. x 18 ft. tubes.

1—250 hp. Cahall boiler, 126-4 in. x 18 ft. tubes.

4—250 hp. National water tube boilers, 150-4 in. x 16 ft. tubes.

1—350 hp. Cahall water tube boiler, 168-4 in. x 18 ft. tubes.

1—400 hp. B. & W. water tube boiler, 196-4 in. x 18 ft. tubes, B. & W. 75 deg. superheater.

1—600 hp. B. & W. water tube boiler, 294-4 in. x 18 ft. tubes, B. & W. 75 deg. superheater.

1—500 hp. Edgemoor boiler, 248-4 in. x 18 ft. tubes. Foster 75 deg. superheater.

3—115 hp. Kendall horizontal return tubular boiler, 114-3 in. x 18 ft. tubes.

2—150 hp. Kendall horizontal return tubular boilers, 140-3 in. x 16 ft. tubes.

2—150 hp. New England Iron Works Co. horizontal return tubular boilers, 132-3 in. x 16 ft. tubes.

1—600 hp. B. & W. water tube boiler, 294-4 in. x 18 ft. tubes.

1—250 hp. B. & W. water tube boiler, 126-4 in. x 18 ft. tubes.

3—185 hp. B. & W. water tube boilers, 108-4 in. x 16 ft. tubes.

2—500 hp. B. & W. water tube boilers, 252-4 in. x 18 ft. tubes, 80 deg. B. & W. superheater.

1—500 hp. B. & W. water tube boiler, 252-4 in. x 18 ft. tubes, 50 deg. B. & W. superheater.

3—250 hp. B. & W. water tube boilers, 126-4 in. x 18 ft. tubes.

1—125 hp. Hewey horizontal return tubular boiler.

ENGINES

2—500 hp. Greene tandem-compound engines for belt drive, size 17 x 33 x 48, speed 104, fly wheels 49 in. face by 16 ft. diameter.

3—500 hp. Hamilton-Corliss tandem-compound engines, size 18 x 34 x 48, speed 72 r.p.m., fly wheels 38 in. face, 22 ft. diameter.

One 700 hp. Cooper cross-compound engine, size 20 x 36 x 48, speed 75 r.p.m., flywheel 49 in. face, 20-ft. diameter.

1—300 hp. Harris Simple engine, size 22 x 48, speed 79 r.p.m., belt wheel 32 in. face, 17 ft. diameter.

1—125 hp. McIntosh & Seymour high speed horizontal engine.

GENERATORS

2—500 kw. G. E. 550 volt, 350 r.p.m., 4 pole, direct current generators.

3—300 kw. G. E. 550 volt, 400 r.p.m., 4 pole, direct current generator.

1—250 kw. Seamens-Halski, 550 volt, 440 r.p.m., 6 pole, direct current generator.

1—Booster Set, 59 hp., 900 r.p.m., 550 volt, motor, direct connected to 55 kw., 4 pole generator, 200 volt boost.

1—250 kw. Westinghouse 500 volt, 420 r.p.m., 4 pole, direct current generator.

2—45 kw. 110 volt, G. E. direct current generators.

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2—20 x 42 Hamilton Heavy Duty Corliss Engines. 1—22 x 48 x 48 Hamilton Heavy Duty Cross Compound Engine. 1—11 x 20 Nagle Corliss. 1—20 x 21 Erie City 4-valve Heavy Duty Engine.

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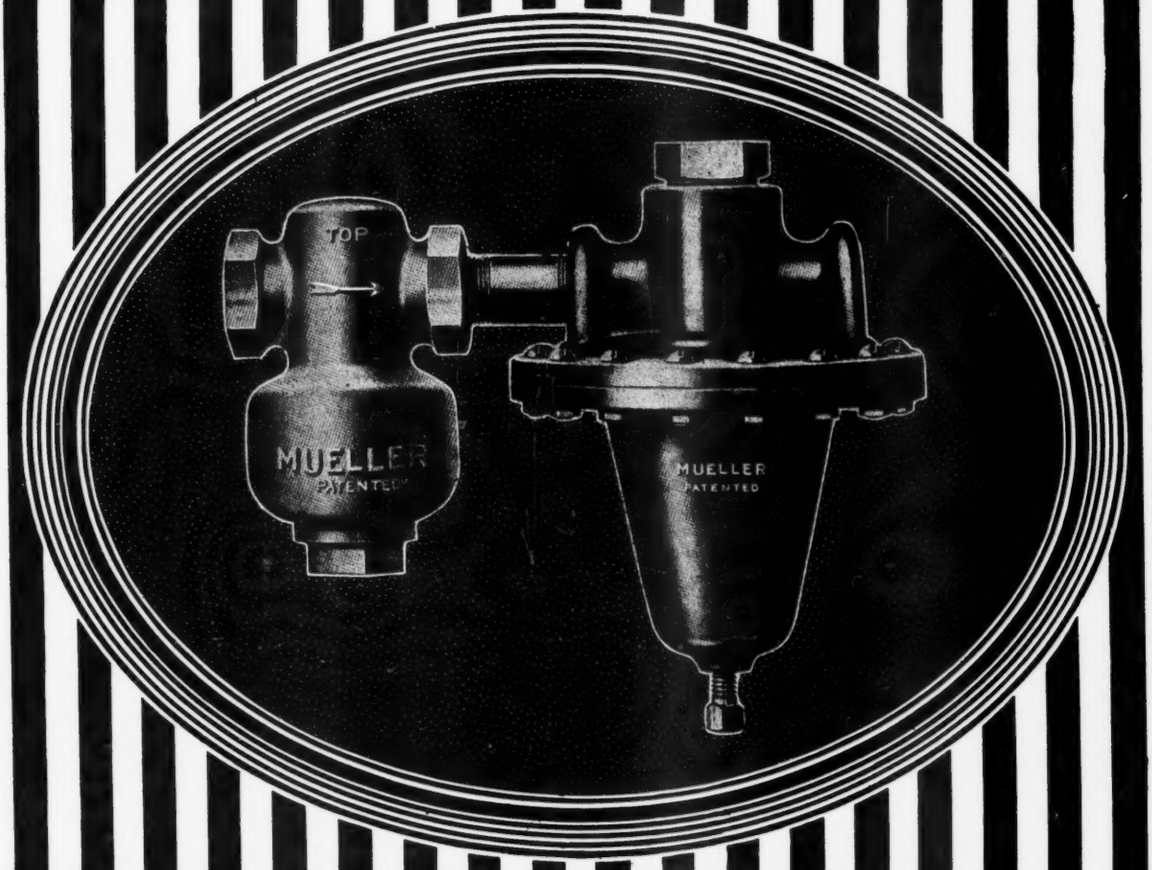

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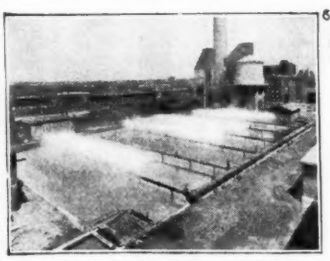

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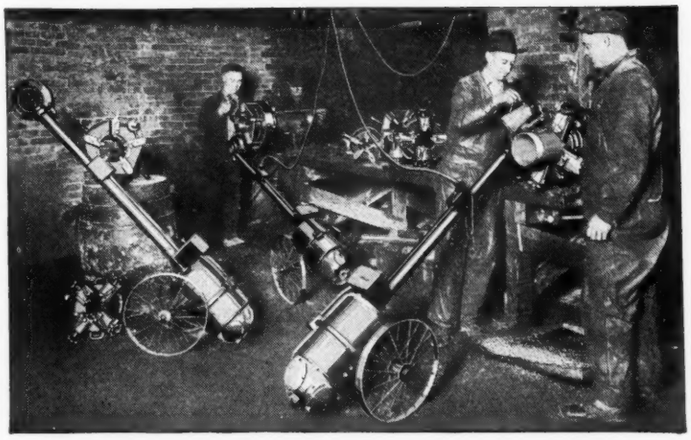

POWER plant superintendents, who are strongly in favor of standardization in equipment and supplies, will be interested in the wide service scope and all-around efficiency of "Toledo" Pipe Tools.

The "Toledo" equipment shown on the bench comprises threaders for pipe from 2½ to 12 inches, and cutters capable of cutting pipe from 2½ to 10 inches in diameter; and the absence of ratchet handles is compensated by the use of "Toledo" Power Drives which rotate these threaders and cutters five times faster than by hand.

In power plants where pipe-fitting tools must be portable, dependable and highly efficient, the "Toledo" line has no peer.

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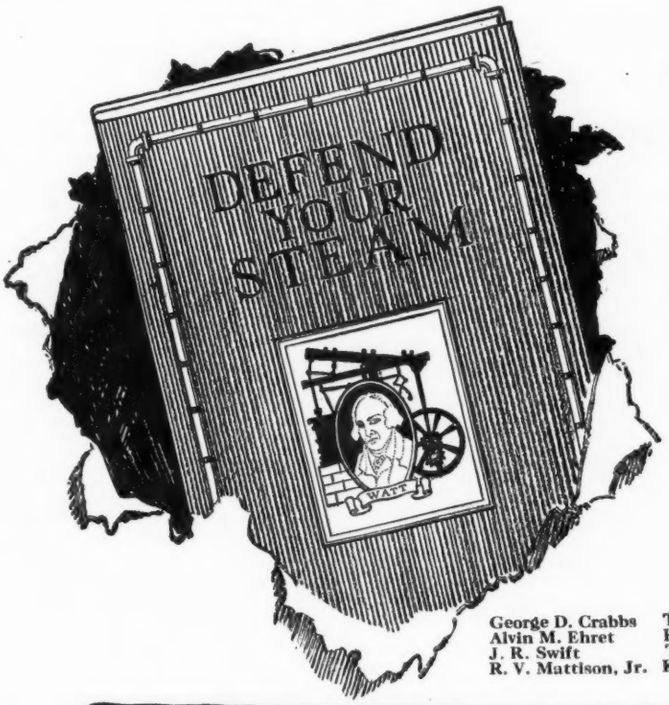

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if you are interested in getting the most out of steam. This revised and enlarged book is a practical treatise on the proper insulation of pipes, boilers, tanks, filters and all other high-pressure steam equipment. The book is freely illustrated with views of a great variety of applications, has numerous charts, tables, etc. Your request puts you under no obligation whatever, but the expense of preparing this practical volume has been such that a copy should be asked for only by those really interested in power and heating economy.

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IT THREADS PIPE ACCURATELY

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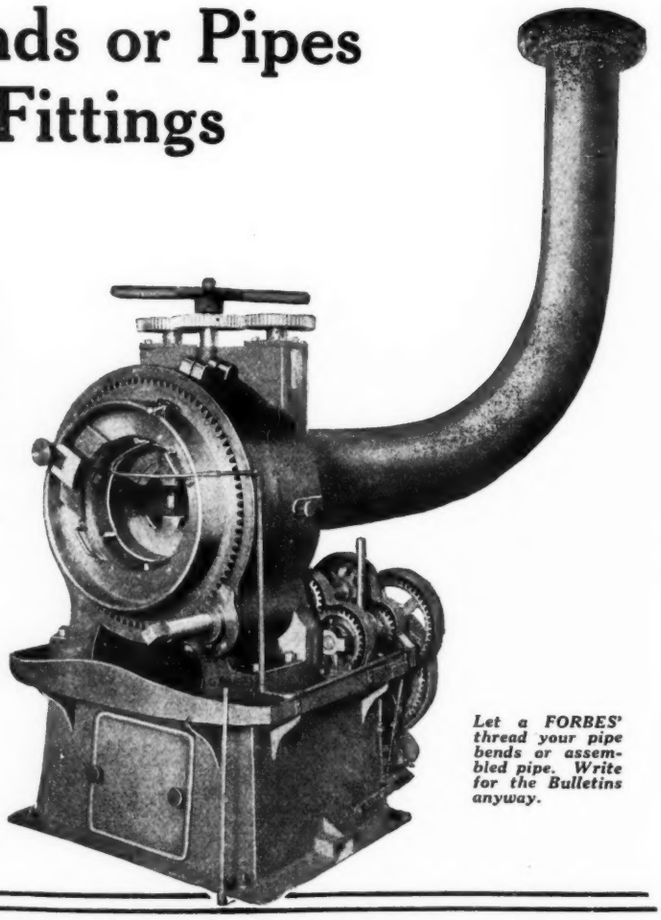

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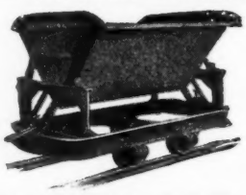

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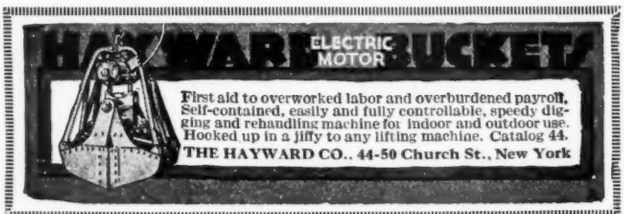

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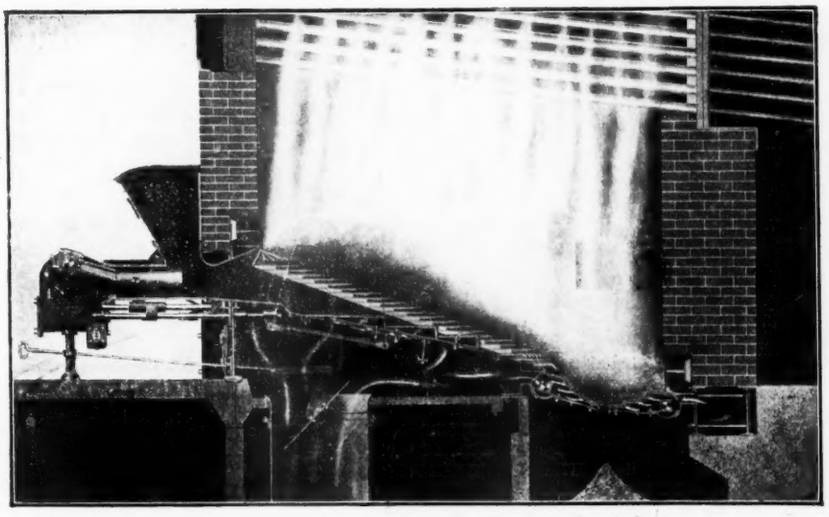

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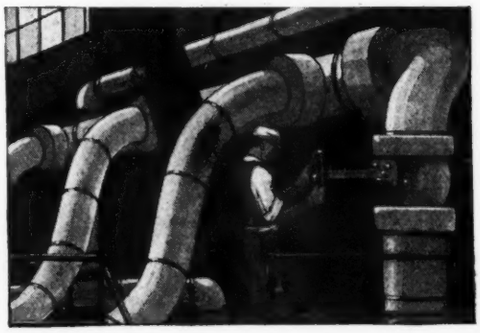

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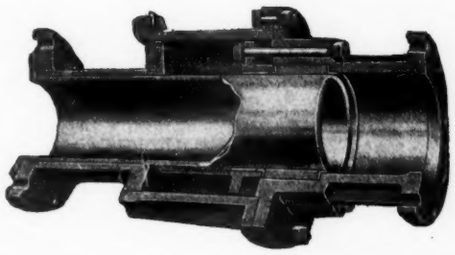

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Gravity Pressure Filters

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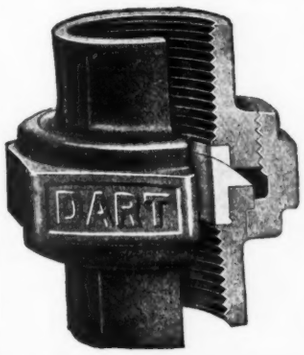
They Have *Proved Satisfactory*



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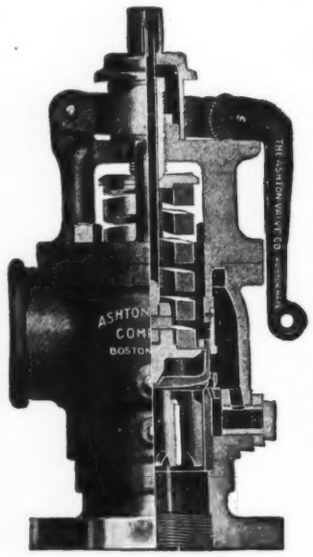

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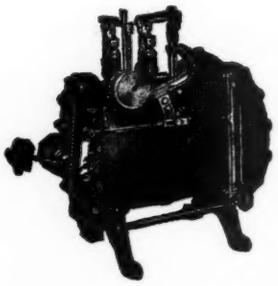

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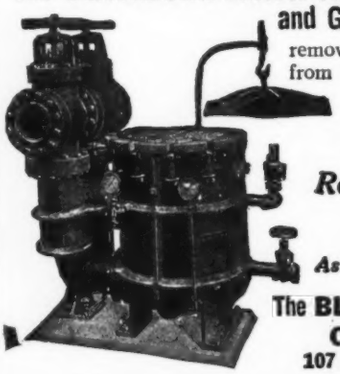

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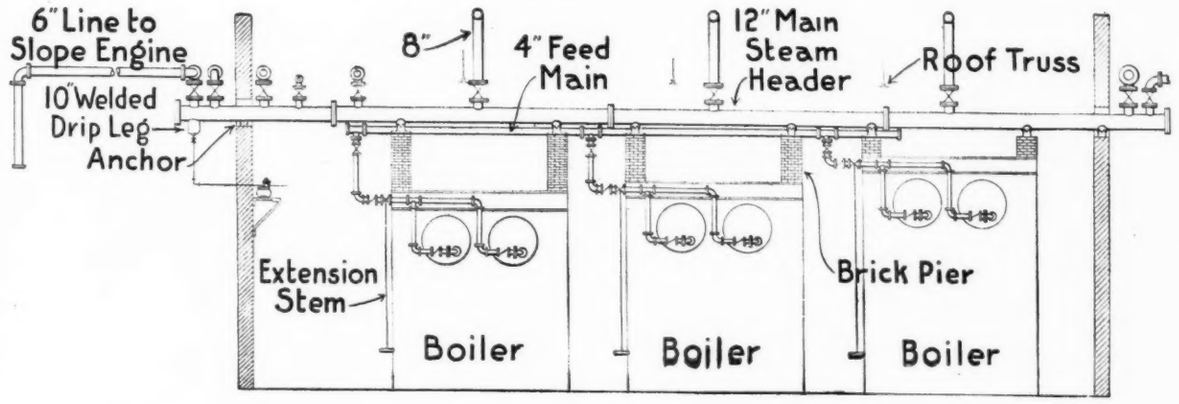

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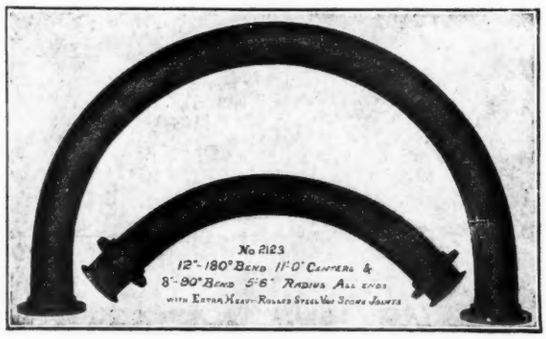

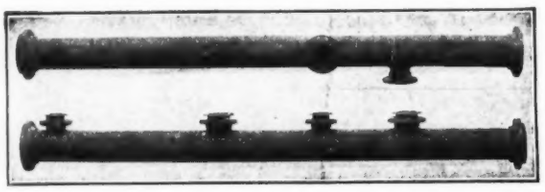

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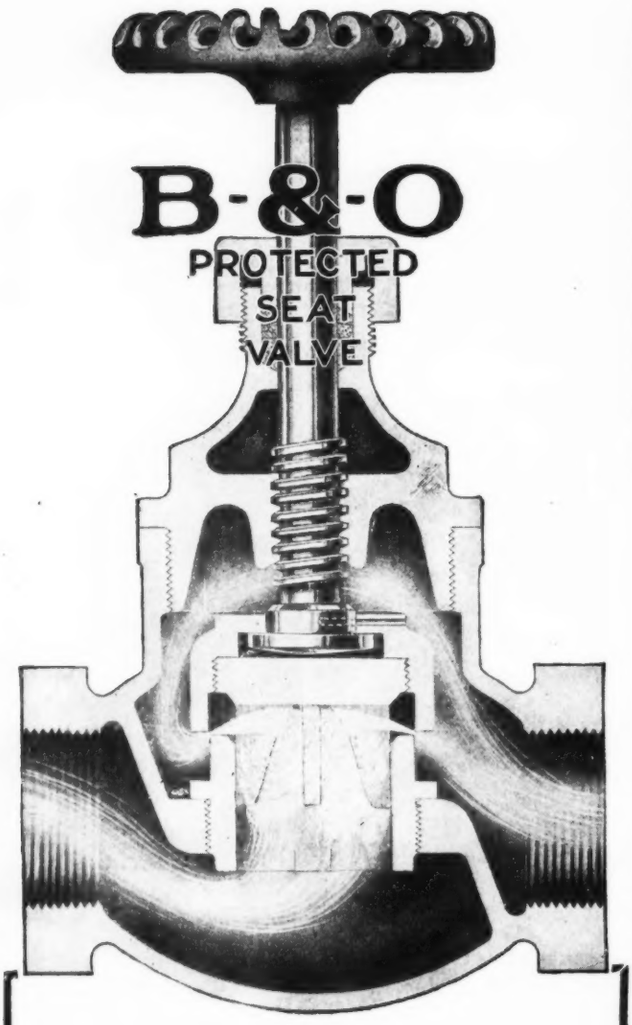

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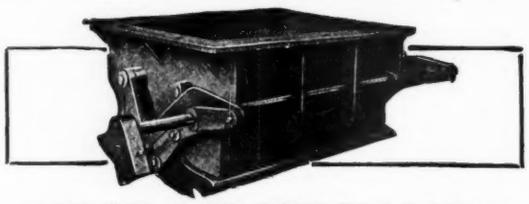

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A HIGH water level in the beaver pond was essential to the life of the beaver colony. They constructed their dams with amazing skill and provided the necessary water level in the ponds for every occasion—summer and winter, draught or flood.

The modern power plant, like the beaver colony, depends also upon its water supply. Boilers must be filled to a certain level—raised or lowered as required. Insufficient water or an unreliable source of supply at times means danger—over supply affects economy and operation. The wise engineer depends upon a reliable feed water pump to supply his boilers with sufficient water for any requirement.

The COPPUS Turbo Boiler Feed Pump has proved in every instance to be the solution of this problem as it operates with unfailing reliability and keeps the water level where the engineer wants it. Its simplicity is its safeguard against pump trouble.

Only one moving part, the double stage turbine wheel rigidly connected by the shaft to the impeller which forces the water into the boiler against pressure. No valves, no water plungers, no pistons, nothing to become loose or to require constant attention.

The COPPUS Turbo Boiler Feed Pump has been accepted by progressive engineers as essential to boiler room efficiency and you too will quickly recognize its superiority over two-unit, centrifugal or reciprocating pumps.

Bulletin and complete information gladly sent on request.

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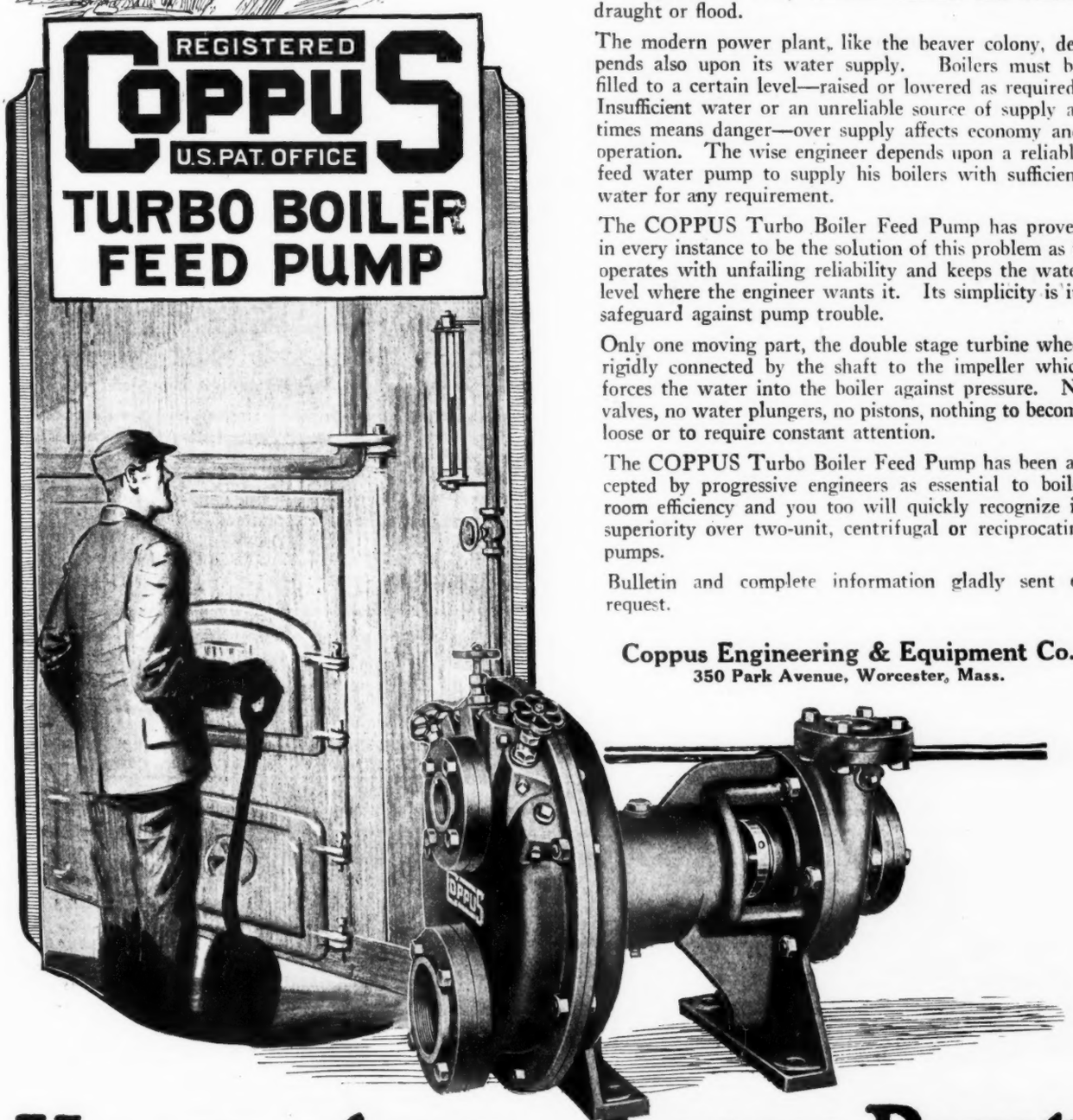
350 Park Avenue, Worcester, Mass.



You can rely on a Coppus Pump

For Constant Reduced Pressure

On your heating, auxiliary steam or air lines be sure to specify and use.

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Reducing Valves

Made in all sizes and capacities to meet every practical condition.

The all bronze pattern shown is guaranteed for any initial operating pressure up to 300 lb. Maintain a positively constant reduced pressure irrespective of pressure fluctuations on the initial side or changes in the volume of steam passed.

Iron body, bronze mounted style guaranteed up to 180 lb. initial pressure.

Order from your dealers. Consult us for technical information.

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Why Hesitate?

A 90 days' free trial on your own pipe lines will prove conclusively that

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are absolutely dependable in holding the joints positively tight under hard service conditions.

The deeply corrugated copper with the alternate rings of strongly spun asbestos, form a perfect labyrinth that will allow nothing to get by.

There is plenty of spring to take up expansion or inequalities in the flange faces or alignment.

Furnished for any pressure or temperature in any required size for pipe lines, heaters, digesters, tanks, etc. Can be used over again repeatedly.

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Built for those who recognize and appreciate a product of quality.

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Walworth High Temperature Gate Valves are made with Rising, as well as Non-Rising, Stem, Wedge Gate and Gland, in sizes ½ to 3 inches. They are sufficient for 250 lbs. steam pressure, 500 and 700 degrees total temperature.

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TURBO-FEED PUMP for better boiler feed supply

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will meet the most exacting requirements. We will be pleased to figure on your present needs.

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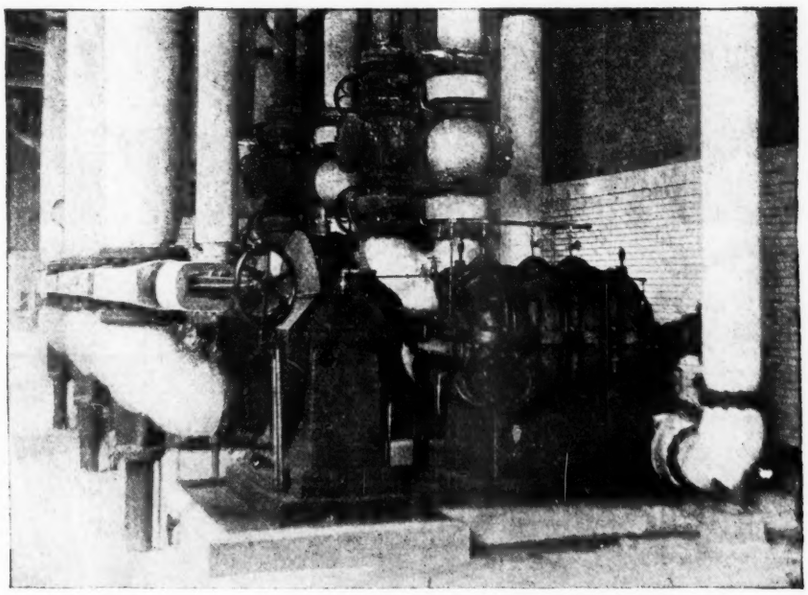


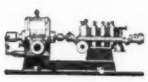
The pumps pictured are the first three installed of a battery of Worthington centrifugal boiler feed pumps

Maximum boiler feed economy and reliability in this 300,000 K.W. station are assured by Worthington apparatus

ELECTRICAL WORLD, April 2, 1921, describes the Colfax power plant as: "Conservative and simple in its layout and equipment, it is nevertheless notable because of its location, ultimate rating and features which have been incorporated in the design to attain high economy and reliability of operation."

Worthington contributions toward "high economy and reliability of operation" are—

Two centrifugal service pumps D.S. 4"—500 G.P.M.



Three centrifugal boiler feed pumps D.S. 8"—1500 G.P.M. 4 stage—400 H.P.

And two motor-driven well pumps 750 G.P.M.—156′ head.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
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B16

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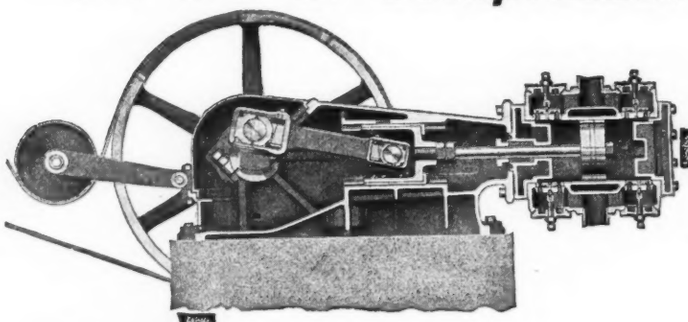
The Man Who Knows Machinery Comes to Pennsylvania for Pumps— for an Air Compressor or Vacuum Pump



BECAUSE he appreciates that they are a better investment—in that they assure better service throughout a long life.

He welcomes the Pennsylvania Compressor improvements; the leak proof lubrication system and its sight oil gauge, the taper fitted fly-wheels, drop forged crank-shaft and closed end connecting rod, and the Pennsylvania Ring Plate Valves that are tight from the start.

He counts the saving in power input to a Pennsylvania Pump and rates it high for its entire accessibility. He knows he can count on continuous service because its shaft, impeller, wearing rings and bearings have the mark of improvement over other designs.

Having learned to know the Pennsylvania line he is not satisfied with any thing less high in quality.

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Air Compressors and Vacuum Pumps

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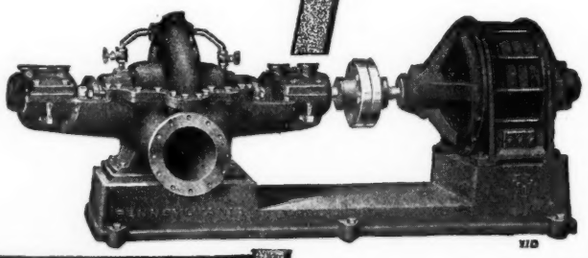

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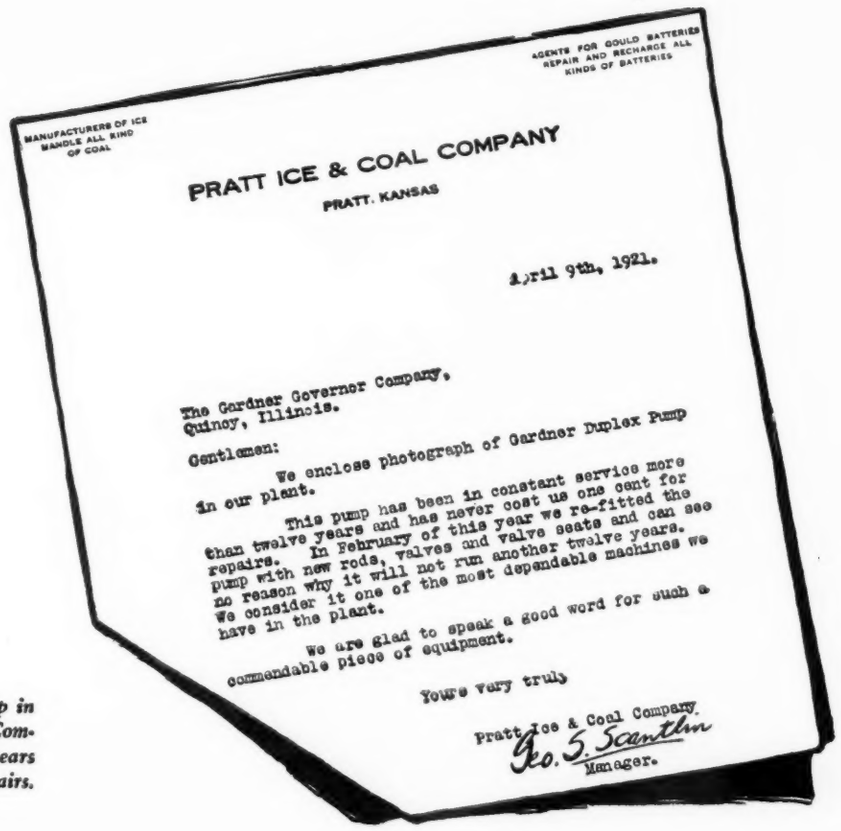

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AGENTS FOR GOULD BATTERIES
REPAIR AND RECHARGE ALL
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PRATT ICE & COAL COMPANY
PRATT, KANSAS

April 9th, 1921.

The Gardner Governor Company,
Quincy, Illinois.

Gentlemen:

We enclose photograph of Gardner Duplex Pump in our plant.

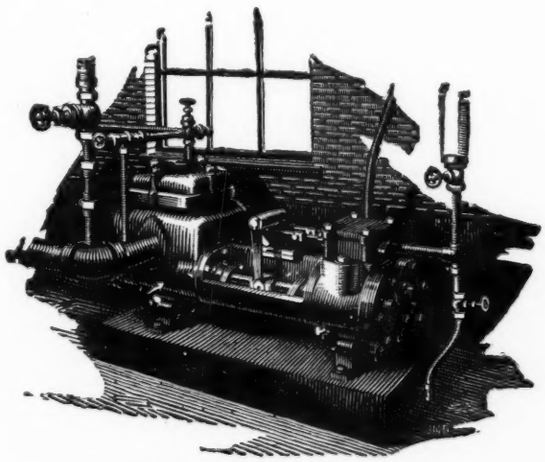
This pump has been in constant service more than twelve years and has never cost us one cent for repairs. In February of this year we re-fitted the pump with new rods, valves and valve seats and can see no reason why it will not run another twelve years. We consider it one of the most dependable machines we have in the plant.

We are glad to speak a good word for such a commendable piece of equipment.

Yours very truly

Pratt Ice & Coal Company.
Geo. S. Scantlin
Manager.

Gardner Duplex Steam Pump in plant of Pratt Ice & Coal Company, Pratt, Kans. Twelve years of service—not one cent for repairs.



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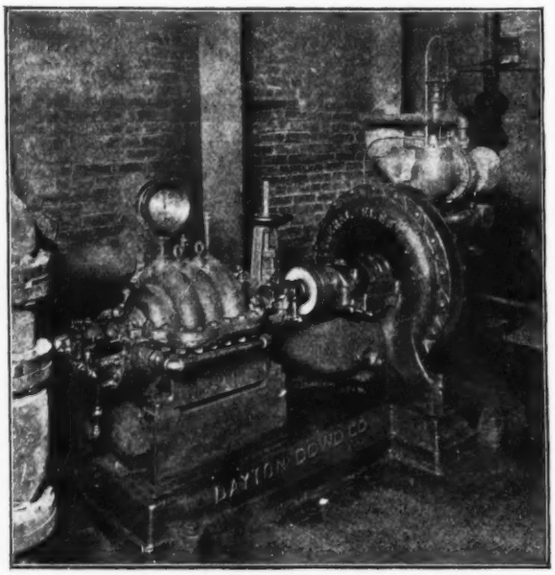
Compare This with Your Boiler Feed Pump



The new **Laurel Line** power plant of the Lackawanna and Wyoming Valley R. R. at Scranton, Pa., designed and built by Ford, Bacon and Davis, Engrs., is equipped with a DAYTON-DOWD Centrifugal boiler feed pump driven by steam turbine. The pump is a type CSU 3 in., three stage, automatically balanced type, having a capacity of 300 GPM against 200 Lbs., operating at 2750 RPM. The turbine is 70 HP.

No matter what your pumping problem is—boiler feeding—condensation service—hydraulic pressure—waterworks, etc., there is a type and size Dayton-Dowd Centrifugal to efficiently meet your conditions.

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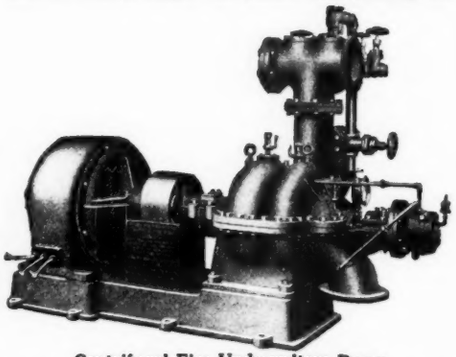

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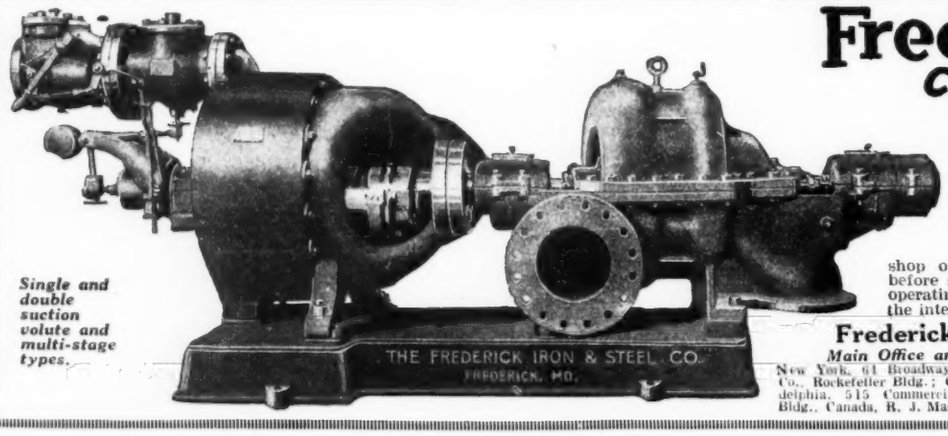

Single and double suction volute and multi-stage types.

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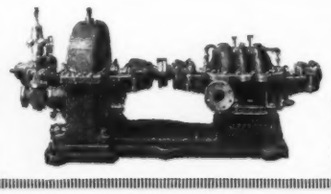

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Centrifugal pumping machinery for every kind of pumping service.

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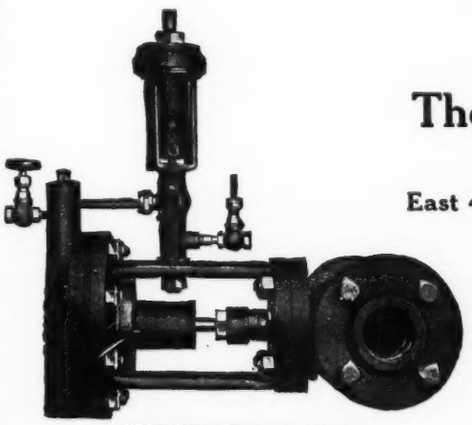

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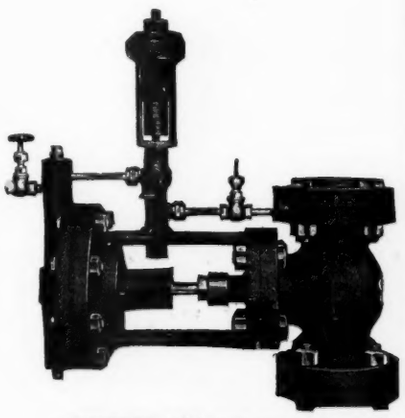

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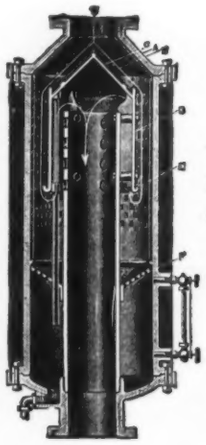

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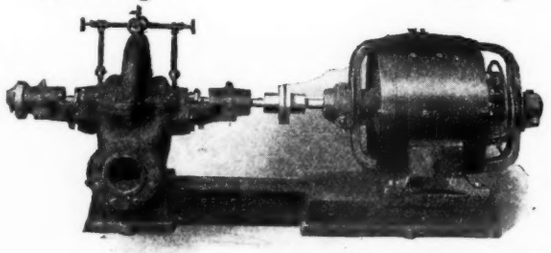

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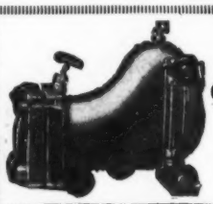

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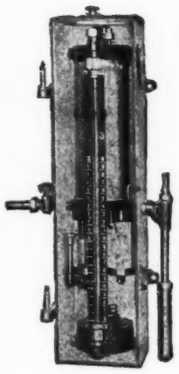

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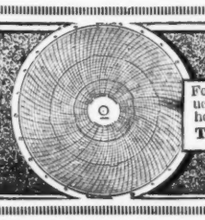

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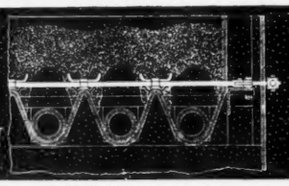

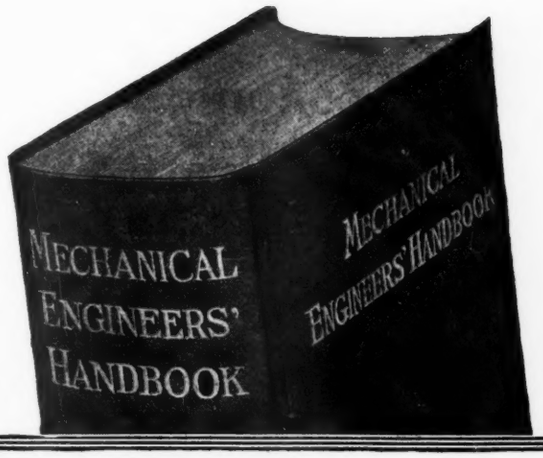

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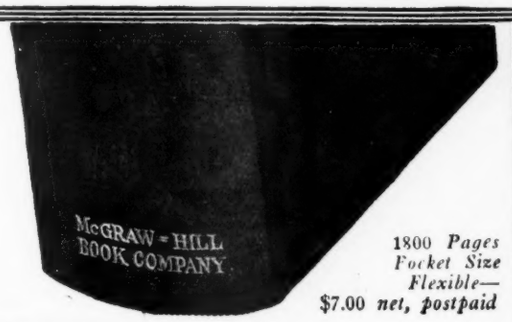

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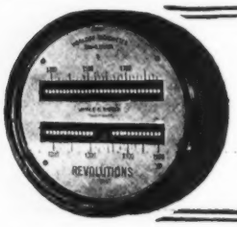

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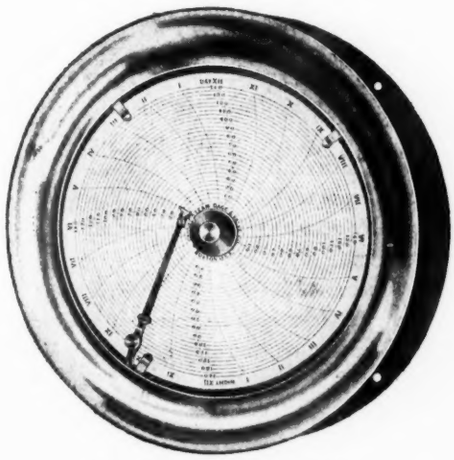

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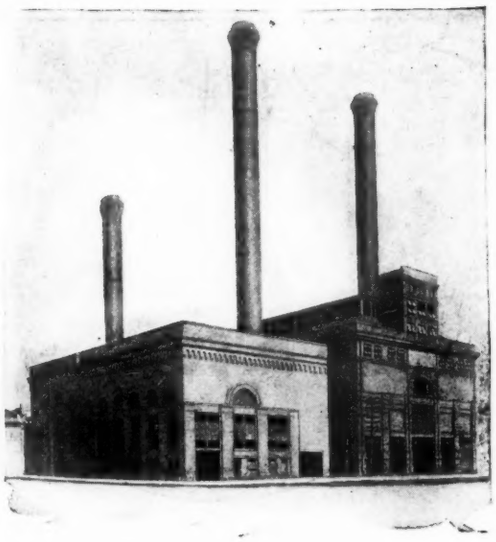

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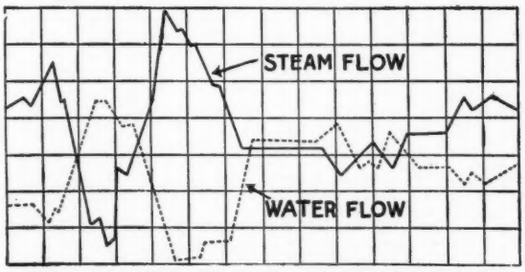

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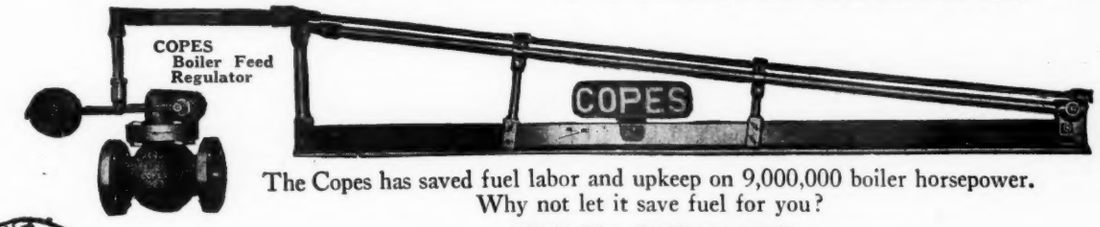

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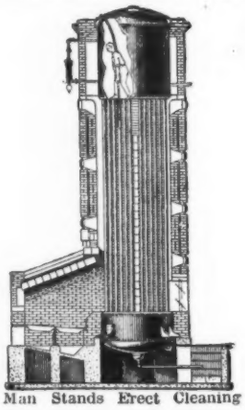

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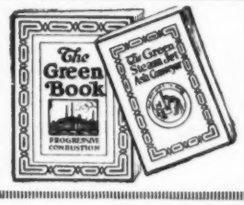

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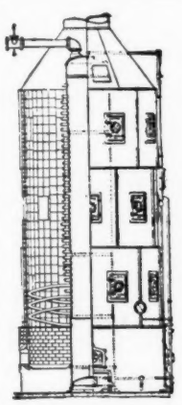

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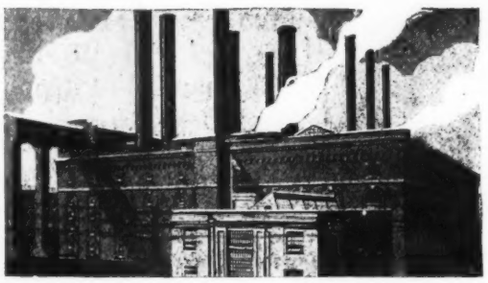

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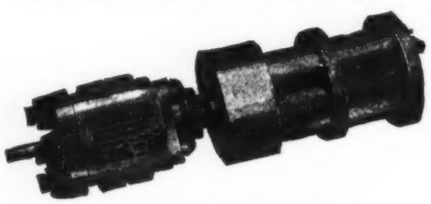

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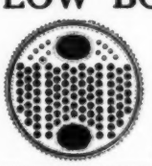

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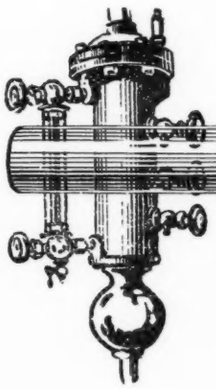

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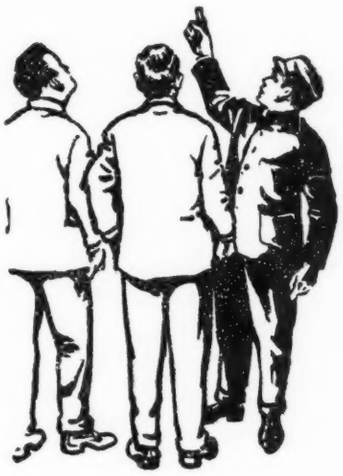

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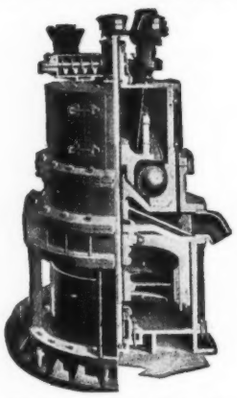

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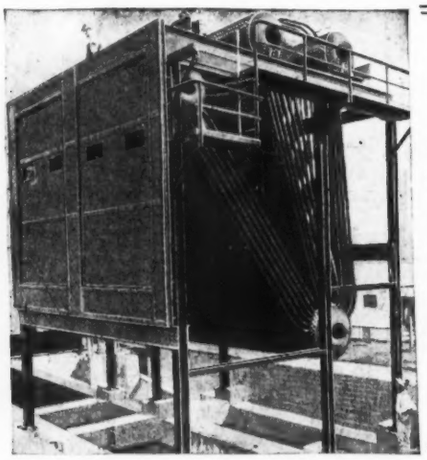

This picture shows a 1058-H.P. unit at Andrews Steel Co., Newport, Ky.

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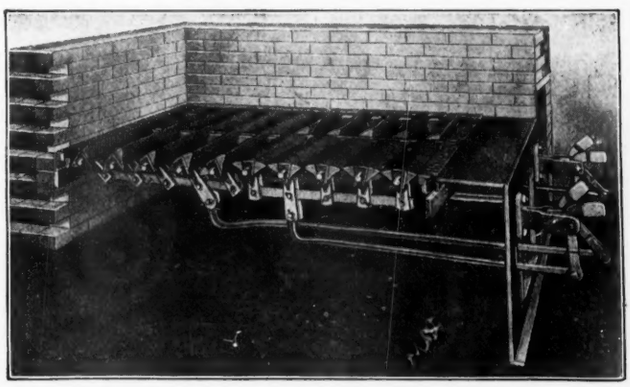

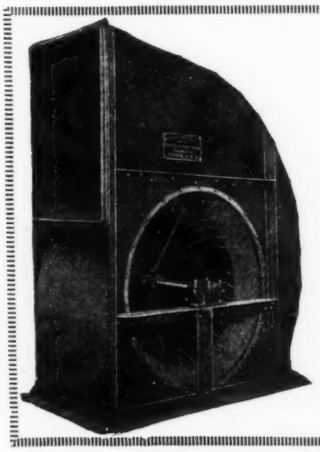

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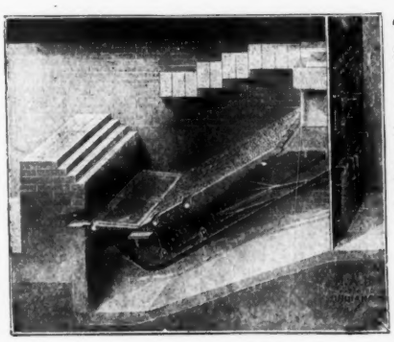

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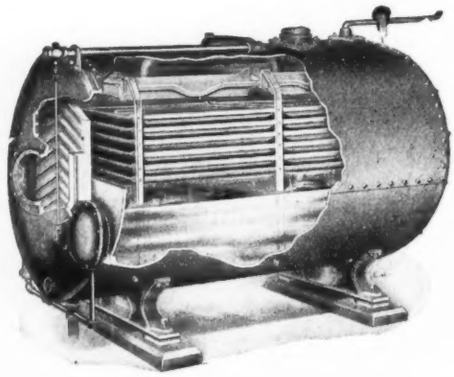

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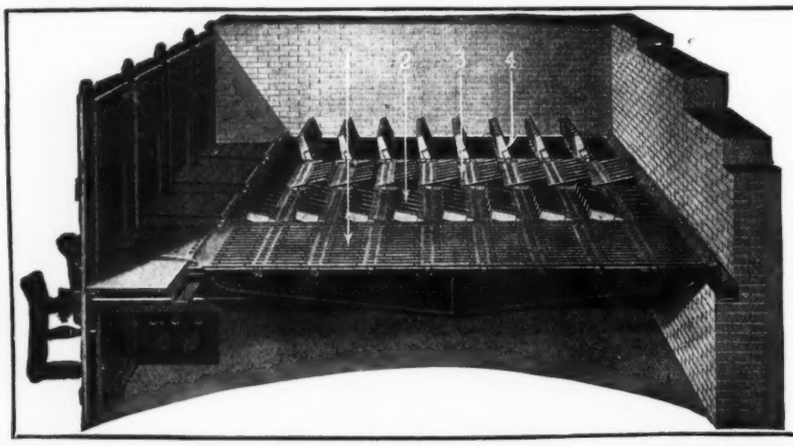

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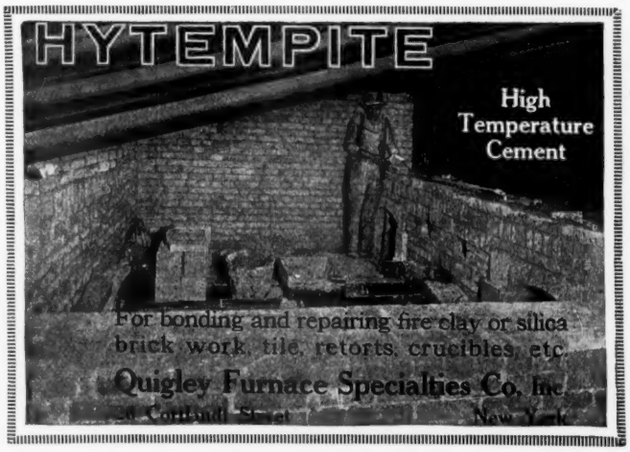
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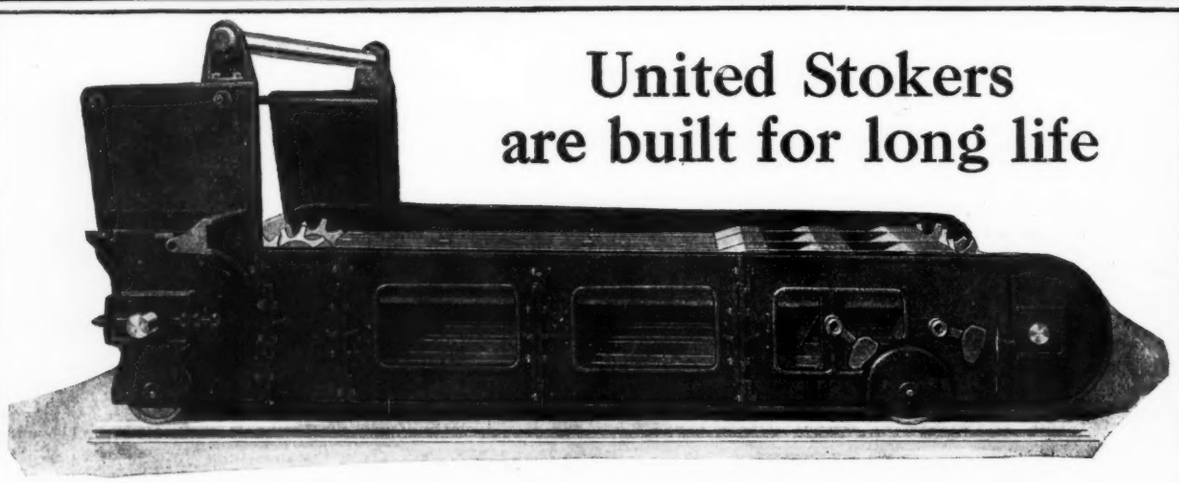

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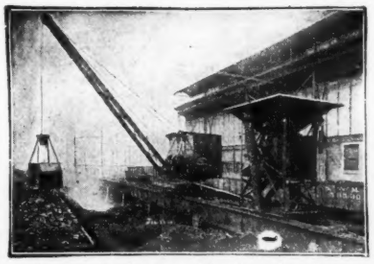

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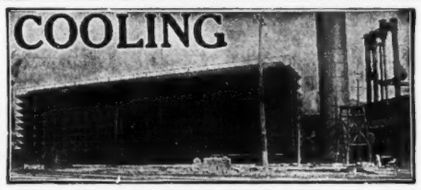

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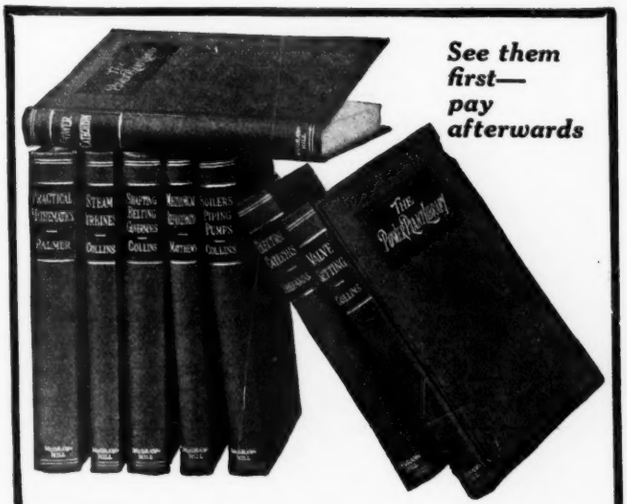

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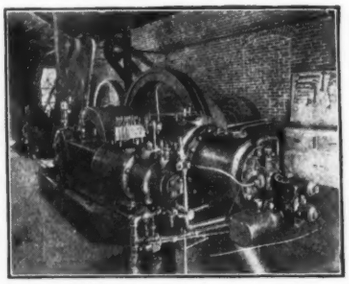

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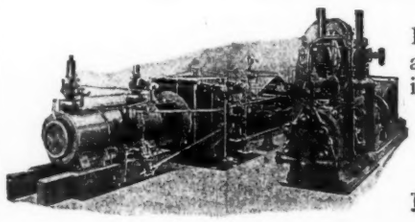

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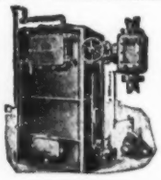

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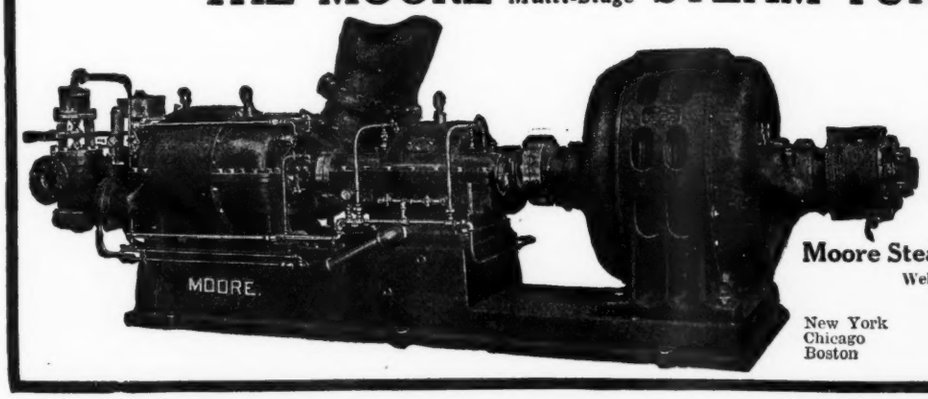

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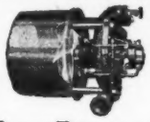

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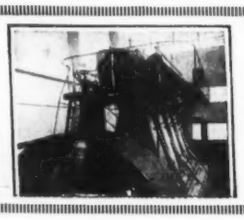

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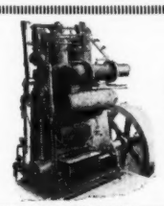

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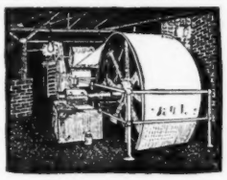

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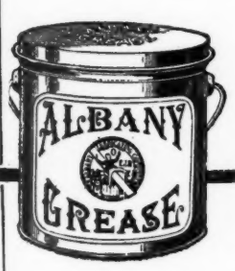

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C-77

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Equipment, Apparatus and Supplies Used in the Power Plant Field with Names of Manufacturers and Distributors

Please refer to the Buying Section for addresses of concerns listed in this directory.
See Last Page for Alphabetical Index

Air Aftercoolers and Receivers
Biggs Boiler Works Co
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Air Compressors
Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.
De La Vergne Machine Co.
General Electric Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.
Norwalk Iron Wks.
Pennsylvania Pump & Compressor Co.
Sullivan Machinery Co.
Weber Subterranean Pump Co.
Worthington Pump & Mach. Corp.

Air Ejectors
Elliott Company.
Wheeler Mfg. Co., E. H.

Air Separators
Elliott Company.
Griscom-Russell Co.

Air Washers
Badger & Sons Co., E. B.
Binks Spray Equipment Co.

Alarms, Low Water
Elliott Co.
Lunkenheimer Co.
Reliance Gauge Column Co.
Wright-Austin Co.

Alternators, Turbo
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Ridgway Dynamo & Eng. Co.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Arches, Boiler Furnace
(See Boiler Arches and Setting)

Asbestos Brake Band Lining and Brake Blocks
Johns-Manville, Inc.

Asbestos Materials
Johns-Manville, Inc.

Ash Bin Gates
(See Gates Bin)

Ash and Coal Handling Machinery
(All Coal and Ash Handling Machinery)

Ash Gates
Conveyors Corp. of America

Ash Pit Doors
Conveyors Corp. of America
Frederick Engineering Co.
Green Engr. Co.

Ash Tanks, Cast Iron
Conveyors Corp. of America
Green Engineering Co.

Ash Tanks, Steel
Heine Safety Boiler Co.

Balanced Draft
Engineer Co.

Batteries, Storage
International Battery Co.

Bath Heaters
Griscom-Russell Co.

Bearings, Oilless
Bound Brook Oilless Bearings
Belt Cement
Schieren Co., Chas. A.

Belt Dressing
Cling-Surface Co.
Dixon Crucible Co., Jos.
Keystone Lubricating Co.
Rhoads & Sons, J. E.
Schieren Co., Charles A.
Texas Co., N. Y. C.

Belting
Pioneer Rubber Works
Garlock Packing Co.
Greene, Tweed & Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Quaker City Rubber Co.
Rhoads & Sons, J. E.
Schieren Co., Charles A.

Belting, Conveyor
Chain Belt Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Pioneer Rubber Mills

Belting Leather (Waterproof)
Schieren Co., Chas. A.

Belting, Link Leather
Schieren Co., Chas. A.

Belting, Rubber
Quaker City Rubber Co.

Bins
Brown Hoisting Mchy. Co.
Green Engr. Co.

Blast Furnace Gas Regulators
Hagan Corp.

Blast Gates
Clarage Fan Co.
Rockwell Co., W. S.

Blowers, Centrifugal
Coppus Eng'g & Equip. Co.
General Electric Co.
Green Fuel Economizer Co.
Sterling Blower Co.
Wing Mfg. Co., L. J.

Blower Control
Automatic Fuel Saving Co.

Blowers, Fan
Buffalo Forge Company
Coppus Eng'g & Equip. Co.
Clarage Fan Co.
De Laval Steam Turbine Co.
Engineer Co.
General Electric Co.
Green Fuel Economizer Co.
Green Engr. Co.
Griscom-Russell Co.
Power Turbo Blower Co.
Sterling Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.
Wing Mfg. Co., L. J.

Blowers, Forced Draft
Clarage Fan Co.
Coppus Eng'g & Equip Co.
Marion Mch., Fdry. & Supply Co.
Sterling Blower Co.
Wing Mfg. Co., L. J.

Blowers, Soot
Adriance-Bate Corp.
Diamond Power Spec. Co.
Huyette Co., The Paul B.
Marion Mch., Fdry. & Supply Co.
Vulcan Soot Cleaner Co.

Blowers, Steam Jet
Chesterton Co., A. W.
Eynon-Evans Corp.
McClave-Brooks Co
Marion Mch., Fdry. & Supply Co.
Schutte & Koerting Co.
Sterling Blower Co.
Blowers, Turbine
Coppus Eng'g & Equip. Co.
Ingersoll-Rand Co.
Kerr Turbine Co.
Sturtevant Co., B. F.
Wing Mfg. Co., L. J.

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Bernitz Furnace Appliance Co., Boston
Betson Plastic Fire Brick Co.
Detrick & Co., M. H.
Drake Non-Clinkering Furnace Block Co.
Green Engr. Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
Illinois Stoker Co.
International Engineering Works
Jointless Fire Brick Co
Liptak Fire-Brick Ach Co.
McLeod & Henry Co.
Obermayer Co., The S.
Pitts & Kitts Mfg. & Supply Co.
Rust Engr. Co.

Boiler Baffle Walls
Betson Plastic Fire Brick Co.
Engineer Co., The
Johns-Manville, Inc.
Jointless Fire Brick Co.
McLeod & Henry

Boiler Brick Work Seal
Shaw & Co., L. S.

Boiler Compound
Bird-Archer Co., The
Chicago Chemical Co.
Dixon Crucible Co., Jos.
Hawkeye Compound Co.
McLeod & Henry
Perolin Co. of America

Boiler Feed Pumps
(See Pumps, Boiler Feed)

Boiler Feed Water, Make Up Plants
Griscom-Russell Co.

Boiler Furnace Linings
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Johns-Manville, Inc.
Jointless Fire Brick Co.
McLeod & Henry
Obermayer Co. The S.
Pitts & Kitts Mfg. & Supply Co.

Boiler Graphite
Dixon Crucible Co. Jos.

Boiler Insulation
Celite Products Co.

Boiler Skimmers
Yarnall-Waring Co.

Boiler Tube Cap Reseating Machine
Lagonda Mfg. Co.

Boiler Tube Cleaners
(See Blowers Soot)
(See Scale Removers)

Boiler Tube Protectors
Cruise & Co.

Boiler Tube Welding
General Specialty Co., The

Boiler Tubes
Amer. Tube & Pipe Bend. Co.
Boiler Tube Co. of America
National Tube Co.
Parkesburg Iron Co.
Pittsburgh Steel Tube Co.
Yarnall-Waring Co.

Boilers, Internally Fired
Fitzgibbons Boiler Co.

Boilers, Return Tubular
Coatesville Boiler Works
Keeler Co., E.
Lebannon Boiler Works
Petty & Co., J. K.
Union Iron Works
Vogt Machine Co., Henry

Boilers, Vertical Water Tube
Babcock & Wilcox Co., The
Erie City Iron Works
Edge Moor Iron Works
Marion Mch., Fdry. & Supply Co.
Morrin Climax Boiler Co.
Wickes Boiler Co.

Boiler Walls
Liptak Fire-Brick Ach Co.

Boilers, Water Tube
Abendroth & Root Mfg. Co.
Babcock & Wilcox Co., The
Badenhausen, Philips
Keeler Co., E.
Connelly Boiler Co., D.
Heine Safety Boiler Co., St. Louis
International Engineering Works
Ladd Co., Geo. T.
Page Boiler Co.
Springfield Boiler Co.
Union Iron Works
Vogt Machine Co., Henry

Bolts and Nuts, Monel Metal
The International Nickel Co.

Books
McGraw-Hill Book Co., Inc.

Breechings
Lancaster Iron Works

Brick, Fire
Bernitz Furnace Appliance Co.
Betson Plastic Fire Brick Co.
Green Engineering Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refrac-
McLeod & Henry Co.
Obermayer Co., The S.
Taylor Sons Co., Chas.

Brick Fire Cement
King Refractories Co.
Pitts & Kitts Mfg. & Supply Co.

Brick Insulating
Quigley Furnace Spec. Co.

Brick Making Machinery
Lancaster Iron Works

Brushes, Motor and Generator
Dixon Crucible Co., Joseph
Calebaugh Self Lubr. Carbon Co.
Orton & Steinbrenner Co.
Speer Carbon Co.
Westinghouse Elec. & Mfg. Co.

Bucket Carrier, Pivoted
Jeffrey Mfg. Co.
Link-Belt Co.
Webster Mfg. Co.

Buckets, Clam Shell
Brown Hoisting Mchy. Co.
Link-Belt Co.
Orton & Steinbrenner

Burners, Oil (See Oil Burners)

Bushings
Steel Mill Pkg. Co.

Calorimeters
Schaeffer & Budenberg Mfg. Co.

Cars, Narrow Gauge
Easton Car & Construction Co.

Castings, Acid Resistant
Fuller-Lehigh Co.
Howard Iron Works

Castings, Brass and Iron
Builders Iron Foundry
Hercules Float Works
McClave-Brooks Co.
Neemes Bros.
Nelson Valve Co.

Castings, Grey Iron
Conveyors Corp. of America
Fuller-Lehigh Co.
Harrisburg Fdry. & Mach. Works
Norwalk Iron Works

Castings, Monel Metal
International Nickel Co.

Cement, Iron
Obermayer Co., S.
Smooth-On Mfg. Co.

Cement, Pipe Joint
Dixon Crucible Co., Jos.
Smooth-On Mfg. Co.

Centrifugal Pumps (See Pumps, Centrifugal)

Chain Grates
Jas. A. Brady Fdy. Co.

Chain, Wheel Valve
Babbit Steam Specialty Co.

Chain, Monel Metal
International Nickel Co.

Chains, Block
Link-Belt Co.
Chain Drive
Chain Belt Co.
Jeffrey Mfg. Co.
Link-Belt Co.
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Globe Ventilating Co.

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Rust Engr. Co.
Stack Engineering Co.

Chimneys, Radial Brick
Kellogg Co., M. W.
Rust Engr. Co.

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Richardson-Phenix Co., The

Clamps
Yarnall-Waring Co.

Clamps, Hose
Strong, Carlisle & Hammond Co.

Cleaners, Boiler Tube
(See Blowers, Soot)
(See Scale Removers)

Clutches, Friction
Caldwell Co., Inc., W. E.
Carlyle-Johnson Mach. Co.
Link-Belt Co.
Moore & White Co.
Reliance Gauge Column Co.

Coal Agitators
Ellis, W. E.

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Beaumont Co., R. H.
Brady Foundry Co., James A.
Brown Hoisting Mach. Co.
Chain Belt Co.
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Conveyors Corp. of America
Detrick Co., M. H.
Easton Car & Construction Co.
Frederick Engineering Co.
Gifford-Wood Co.
Girtanner Engr. Corp.
Godfrey Conveyor Corp.
Green Engineering Co.
Guarantee Construction Co.
Hagan Corp.
Hayward Co.
Hunt Co., C. W.
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Lakeside Bridge & Steel So.
Link-Belt Co.
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Sauerman Bros.
Sterling Blower Co.
United Stokers Corp.
Webster Mfg. Co.

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Brown Hoisting Machy. Co.
Conveyors Corp. of America
Green Engineering Co.
Guarantee Construction Co.
Lakeside Bridge & Steel Co.
Link-Belt Co.
Worthington Pump & Machy. Corp.

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Fuller-Lehigh Co.
Jeffrey Mfg. Co.
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Marion Mch. Fdry. & Supply Co.
Orton & Steinbrenner Co.
Webster Mfg. Co.
Worthington Pump & Mchy. Corp.

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Homestead Valve Mfg. Co.
Walworth Mfg. Co.

Cocks, Gage
Chaplin Fulton Mfg. Co.
Huyette Co., Inc., Paul B.
Jenkins Bros.
Lunkenheimer Co.
Pitts & Kitts Mfg. & Supply Co.
Reliance Gauge Column Co.
The Williams Gage Co.
Wright-Austin Co.

Cocks, Steam
Crane Co.
Dart Mfg. Co., E. M.
Homestead Valve Mfg. Co.
Lunkenheimer Co.

Collars, Shaft
Chain Belt Co.
Link-Belt Co.

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Betson Plastic Fire Brick Co.
Detrick Co., M. H.
Green Fire Brick Co., A. P.
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McLeod & Henry Co.
Obermayer Co., The S.

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Ross Heater & Mfg. Co.
Schutte & Koerting Co.
Westinghouse Elec. & Mfg. Co.
Wheeler Cond'r & Engr. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Mach. Corp.

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Ingersoll-Rand Co.
Wheeler Cond'r & Engr. Co.
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Adapti Company

Conduits, Underground
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Automatic Fuel Saving Co.

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Controllers, Electric
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Chain Belt Co.
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Jeffrey Mfg. Co.
Lakeside Bridge & Steel So.
Link-Belt Co.
Quaker City Rubber Co.

Conveyors, Cable
Conveyors Corp. of America
Lancaster Iron Works

Conveyors, Coal and Ash
(See Coal and Ash Handling Machinery)

Conveyors, Soot
Conveyors Corp. of America

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Griscom-Russell Co.

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Schutte & Koerting Co.

Coolers, Oil
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Schutte & Koerting Co.

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Cooling Tower Co.
Spray Engineering Co.
Star Brass Works
Yarnall-Waring Co.

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Burhorn Co., Edwin
Carbondale Machine Co.
Cooling Tower Co.
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Wheeler Cond. & Engr. Co.
Worthington Pump & Mchy. Corp.

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Ajax Flexible Couplings Co.
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Couplings, Shaft
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Smith & Serrell

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Ric-Wil Co.

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General Electric Co.
Johns-Manville, Inc.
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Cutters, Boiler Tubes
(See Pipe Cutters)

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(See Searchlight Section)

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(See Blowers, Fan)

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Terry Steam Turbine Co.

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Vogt Machine Co., Henry

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Clarage Fan Co.
Sturtevant Co., B. F.

Dynamos (See Generators)

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Sturtevent Co., B. F.

Ejectors
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Chaplin-Fulton Mfg. Co.
Eynon-Evans Corp.
Lunkenheimer Co.
Manning Maxwell & Moore, Inc.
Schutte & Koerting Co.
Sherwood Mfg. Co.

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American Steel & Wire Co.

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Conveyors Corp. of America
Jeffrey Mfg. Co.
Lakeside Bridge & Steel Co.
Link-Belt Co.
Orton & Steinbrenner

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Otis Elevator Co.

Engineering Service
(See Directory)

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Lammert & Mann Co.

Rooksby & Co., E. J.
Underwood & Co., H. B.

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Schutte & Koerting Co.
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Nordberg Mfg. Co.
Taylor Machine Co.
Worthington Pump & Mchy. Corp.

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Sterling Engine Co.

Engines, Gas and Oil
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Buckeye Machine Co.
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Cooper Co., C. & G.
De La Vergne Mach. Co.
Fulton Iron Works Co.
Hooven-Owen-Rentschler Co.
Ingersoll-Rand Co.
Power Mfg. Co., The
Taylor Machine Co.
Westinghouse Elec. & Mfg. Co.

Engines, Pumping
Allis-Chalmers Mfg Co.
Nordberg Mfg. Co.
Worthington Pump & Mach. Corp.

Engines, Steam
Allis-Chalmers Mfg. Co.
Ball Engine Co.
Buckeye Engine Co.
Buffalo Forge Co.
Chicago Pneumatic Tool Co.
Clarage Fan Co.
Cooper Co., C. & G.
Erie City Iron Works
Fitchburg Steam Engine Co.
Fulton Iron Works Co.
Harrisburg Foundry & Machine Works
Hooven-Owen-Rentschler Co.
Nordberg Mfg. Co.
Ridgway Dynamo & Eng. Co.
Skinner Engine Co.
Vilter Mfg. Co.
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Mchy. Corp.

Evaporators
Griscom-Russell Co.
Ross Heater & Mfg. Co.
Wheeler Cond. & Engr. Co.
Whitlock Coil Pipe Co.

Evaporator Feed Heaters
Griscom-Russell Co.

Evaporators, Multi-Stage
Wheeler Cond. & Engr. Co.

Exhaust Heads
Burt Mfg. Co.
Direct Separator Co.
Hoppes Mfg. Co.
Ohio Body & Blower Co.
Patterson & Kelley Co., Inc.
Sterling Blower Co.
Sturtevant Co., B. F.
Watson & McDaniel Co.
Whitlock Coil Pipe Co.
Wright-Austin Co.

Expansion Joints
American Dist. Steam Co.
Badger & Sons Co., E. B.
Griscom-Russell Co.
Hercules Float Works
Howard Iron Works
Ross Heater & Mfg. Co.
Warren Webster & Co.
Wheeler Mfg. Co., C. H.

Extension Valve Boxes
Kennedy Valve Mfg. Co.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Feed Water Filters
(See Filters, Feed Water)

Feed Water Heaters
Alberger Heater Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
Nat'l Pipe Bending Co.
Ohio Body & Blower Co.
Patterson Kelley Co.
Permutit Co.
Pratt & Cady Co.
Ross Heater & Mfg. Co.
Warren Webster & Co.
Wheeler Cond. & Engr. Co.
Worthington Pump & Mchy. Corp.

Feed Water Purifiers
Alberger Heater Co.
Blackburn Smith Corp.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
International Filter Co.
Permutit Co.
Pratt & Cady Co., Inc.
Webster & Co., Warren
Yarnall-Waring Co.

Feed Water Regulators
Chaplin-Fulton Mfg. Co.
Elliott Co.
Foster Engineering Co.
Mason Regulator Co.
Northern Equipment Co.
Pitts & Kitts Mfg. & Supply Co.
Squires Co., C. E.
The William Gauge Co.
Wing Mfg. Co., L. J.
Wright Austin Co.

Feeders, Boiler Compound
Bird-Archer Co., The
Lunkenheimer Co.
Richardson-Phenix Co.

Fibre, Sheets, Rods, Tubes and Specialties
Johns-Manville, Inc.
Wilmington Fibre Spec'ty Co.

Filtering & Circulating System for Lubricating Oil
Nugent & Co., W. W.
Richardson Phenix Co.

Filters, Feed Water
Blackburn-Smith Corp.
Griscom-Russell Co.

Filters, Oil
Anderson Co., V. D.
Blackburn-Smith Corp.
Burt Mfg. Co.
Elliott Co.
Nugent & Co., Inc., Wm. W.
Wayne Oil Tank & Pump Co.

Filters, Oil, Removal
Permutit Co.
Richardson-Phenix Co.

Filters, Water
International Filter Co.
N. Y. Continental Jewell Filtration Co.
Permutit Co.
Scaife & Sons, Wm. B.

Fire Brick Arches
Detrick Co., M. H.
Liptak Fire-Brick Arch Co.

Fire Brick, Cement and Mortar
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Johns-Manville, Inc.
Jointless Fire Brick Co.
McLeod & Henry
Obermayer Co., The S.
Pitts & Kitts Mfg. & Supply Co.
Quigley Furnace Specialties Co.
Taylor Sons Co., Chas.

Fire Extinguishers
Badger & Sons Co., E. B.
Johns-Manville, Inc.

Firebox Blocks
Green Fire Brick Co., A. P.
McLeod & Henry Co.
Taylor Sons Co., Chas.

Fittings, Ammonia
Carbondale Machine Co.
Greene, Tweed & Co.
Vogt Machine Co., Henry
York Mfg. Co.

Fittings, Oil Pipe Union Cinch
Richardson Phenix Co.

Fittings, Steel
Crane Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.

Fixtures, Electrical
Adapti Co., The

Flanges
American Dist. Steam Co.
Dart Mfg. Co., E. M.
Jefferson Union Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.
Vogt Machine Co., Henry

Flat Arches
Detrick Co., M. H.
Liptak Fire-Brick Arch Co.

Flat Wire—Strip Steel
Am. Steel & Wire Co.

Floats
Anderson Co., V. D.
Hercules Float Works
Reliance Gauge Column Co.

Flow Meters
(See Meters, Flow)

Floor Gratings
Irving Iron Works

Flooring, Mastic and Cork Tile
Johns-Manville

Flue Cleaners
Adriance-Bate Corp.
Chesterton Co., A. W.
Huyette & Co., Inc., Paul B.
Vulcan Soot Cleaner Co.

Forges
Buffalo Forge Co.

Forgings, Monel Metal
International Nickel Co., The

Fuel Burners
Mechanicville Specialty Supply Mfg. Co.

Fuel Oil
Sun Co., The
Texas Co., The

Fuel Oil Systems
Wayne Oil Tank & Pump Co.

Furnace Blocks
Drake Non Clinkering Furnace Block Co.
McLeod & Henry

Furnace Control Equipment
Automatic Fuel Saving Co.

Furnace Door Arch
Betson Plastic Fire Brick Co.
Detrick Co., M. H.
Jointless Fire Brick Co.
McLeod & Henry Co.
Obermayer Co., The S.
Pitts & Kitts Mfg. & Supply Co.

Furnace Lining
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Jointless Fire Brick Co.
McLeod & Henry
Obermayer Co., The S.
Pitts & Kitts Mfg. & Supply Co.
Quigley Furnace Specialties Co.

Furnace Walls
Liptak Fire-Brick Arch Co.

Furnaces
Automatic Furnace Co.
Cokal Stoker Corporation
Detroit Stoker Company
Green Engineering Co.
Hofft Co., M. A.
Illinois Stoker Co.
McClave Brooks Co.
Murphy Iron Works
Rust Engr. Co.
Sterling Blower Co.

Furnaces, Oil Burning
Wayne Oil Tank & Pump Co.

Fuses
Chicago Fuse Co.
Economy Fuse & Mfg. Co.
General Electric Co.
Johns-Manville, Inc.
Trico Fuse Mfg. Co.
Westinghouse Elec. & Mfg. Co.

Gage Boards
Ashton Valve Co.
Foxboro Co.

Gage Cocks
(See Cocks, Gage)

Gage Glasses
Advance Packing & Supply Co.
Chesterton Co., A. W.
Garlock Packing Co.

Gage Glass Guards and Shields
Paul B. Huyette Co., Inc.

Gage Testing Outfit
Ashton Valve Co.

Gages, Differential
Bailey Meter Co.

Gages, Draft
Bailey Meter Co.
Bristol Co.
Brown Instrument Co.
Ellison, Lewis M.
Hays Corp., Jos. W.
Huyette & Co., Inc., Paul B.
Pierce Co., Wm. B.

Gages, Liquid Level
Foxboro Co.

Gages, Oil
Richardson-Phenix Co.

Gages, Pressure
Ashton Valve Co.
Bristol Co.
Brown Instrument Co.
Crosby Steam Gage & Valve Co.

Gages, Recording
Am. Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Bristol Co.
Foxboro Co.
Hays Corporation, Jos. W.

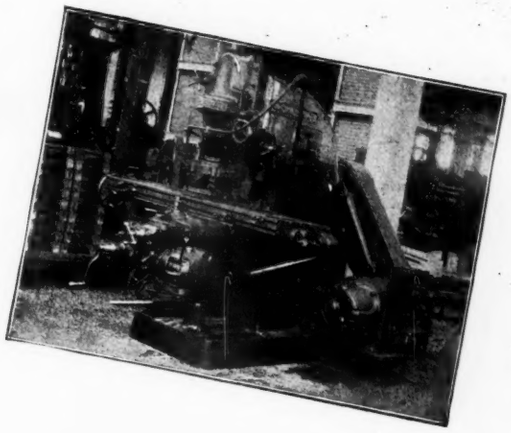
Gages, Vacuum
Ashton Valve Co.
Bristol Co.
Greene, Tweed & Co.

Gages, Water
American Dist. Steam Co.
Crosby Steam Gage & Valve Co.
Greene, Tweed & Co.
Huyette Co., Inc., Paul B.
Jenkins Bros.
Lunkenheimer Co.
Ohio Brass Co.
Pitts & Kitts Mfg. Supply Co.
Reliance Gauge Column Co.
The William Gauge Co.

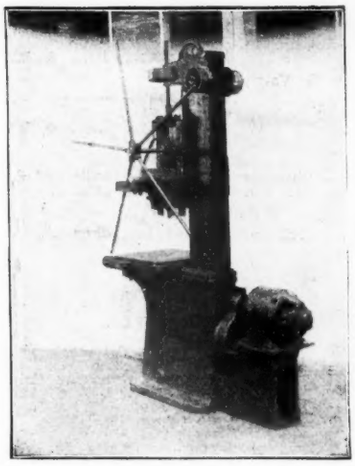
Gas Burners
Tate-Jones & Co. Inc.

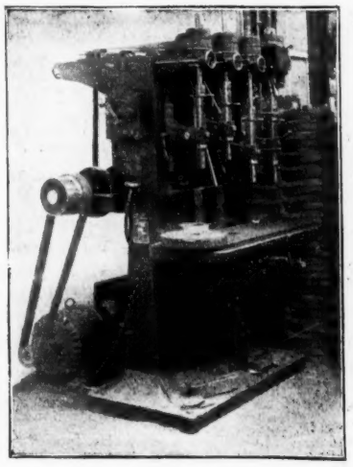
Allis-Chalmers Type "E"

Direct Current Motors



Especially adapted to Machine Tool Service





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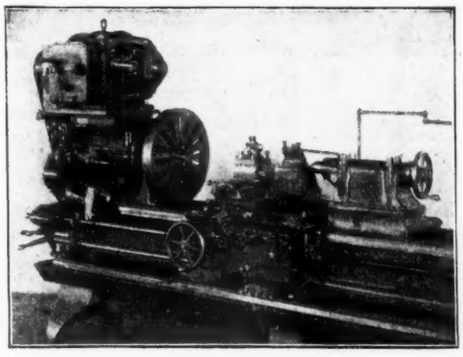


ALLIS-CHALMERS MANUFACTURING COMPANY

ELECTRICAL MACHINERY
STEAM TURBINES — STEAM ENGINES
HYDRAULIC TURBINES
GAS ENGINES — OIL ENGINES
MINING MACHINERY
CRUSHING AND CEMENT MACHINERY
FLOUR AND SAW MILL MACHINERY

PUMPING ENGINES
CENTRIFUGAL PUMPS
CONDENSERS
AIR COMPRESSORS — AIR BRAKES
STEAM AND ELECTRIC HOISTS
AGRICULTURAL MACHINERY
POWER TRANSMISSION MACHINERY

MILWAUKEE, WISCONSIN. U.S.A.

Gas Exhausters
General Electric Co.
Ingersoll-Rand Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.

Gas Producers
Smith Gas Engr. Co.
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Mach. Corp.

Gaskets
Advance Pkg. & Supply Co.
Akron Metallic Gasket Co.
Crane Co.
Eureka Packing Co.
Garlock Packing Co.
Goetze Gasket & Pkg. Co.
Greene, Tweed & Co.
Jenkins Bros.
Johns-Manville, Inc.
Sarco Co.
Smooth-On Mfg. Co.
Wilcox Mfg. Co., E. A.

Gaskets, Asbestos
Akron Metallic Gasket Co.
Johns-Manville, Inc.
Pitts & Kitts Mfg. & Supply Co.

Gaskets, Copper Rubber
Akron Metallic Gasket Co.
Wilcox Mfg. Co., E. A.

Gaskets, Fibre
Wilmington Fibre Specialty Co.

Gaskets, Water Gage
Morse, R. F.

Gasoline Electric Generating Sets
Sturtevant Co., B. F.

Gasoline Storage System
Wayne Oil Tank & Pump Co.

Gates, Bin
Baker Dunbar Allen Sales Co.
Beaumont Co., R. H.
Brown Hoisting Machy. Co.
Conveyors Corp. of America
Green Engr. Co.
Jeffrey Mfg. Co.
Chain Belt Co.
Link-Belt Co.

Gates, Sluice
Chapman Valve Mfg. Co.

Gears
Chain Belt Co.
De Laval Steam Turbine Co.
Earle Gear & Machine Co.
General Electric Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Moore Steam Turbine Corp.

Generating Sets
General Electric Co.
Allis-Chalmers Mfg. Co.
Ridgway Dynamo & Eng. Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Generator Coolers
Badger & Sons Co., E. B.
Binks Spray Equipment Co.
Ridgway Dynamo & Eng. Co.

Generators, Electric
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Ridgway Dynamo & Eng. Co.
Terry Steam Turbine Co.
Westinghouse Elec. & Mfg. Co.

Governors, Pressure
Cash Co., A. W.
Mason Regulator Co.
Northern Equipment Co.

Governors, Pump
Cash Co., A. W.
Chapin-Fulton Mfg. Co.
Davis Regulator Co., G. M.
Edward Valve & Mfg. Co.
Fisher Governor Co., Inc., The
Foster Engineering Co.
Illinois Engineering Co.
Marion Mch., Fdry. & Supply Co.
Mason Regulator Co.
Northern Equipment Co.
Pitts & Kitts Mfg. & Supply Co.
Squires Co. C. E.
Strong, Carlisle & Hammond Co., The
Watson & McDaniel Co.
Warren Webster & Co.
Wright, Austin Co.

Governors, Steam Engine
Gardner Governor Co.

Graphite
Dixon Crucible Co., Jos.
Garlock Packing Co.
Greene, Tweed & Co.
Obermayer Co., S.

Grate Bars
Cokal Stoker Corporation
Furnace Engineering Co., Inc.
Valley Iron Works

Grates
Armstrong Mfg. Co.
Automatic Furnace Co., The
Babcock & Wilcox Co., The
Combustion Eng. Corp.
Cyclone Grate Bar Co.
Flynn & Emrich
Furnace Engineering Co., Inc.
Green Engineering Co.
Hofft, M. A., Co.
International Engineering Works
Kelly Fdry. & Mch. Co.
Marion Mch., Fdry. & Supply Co.
McClave-Brooks Co.
Neemes Bros.
Power Turbo Blower Co.
Valley Iron Works
Vogt Machine Co., Henry
Washburn & Granger, Inc.

Grating, Flooring and Subway
Irving Iron Works

Grease
Adam Cooks Sons Co.
Dixon Crucible Co., Jos.
Keystone Lubricating Co.
N. Y.-N. J. Lubricant Co.
Ohio Grease Co.
Sun Co., The
Texas Company
Tide Water Oil Co.
Vacuum Oil Co.

Grease Extractors
Am. Steam Gage & Valve Mfg. Co.
Blackburn-Smith Corp.
Elliott Co.
Griscom-Russell Co.
Lagonda Mfg. Co.

Grinders, Air & Elec. Portable
Chicago Pneumatic Tool Co.

Hammers, Pneumatic
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Hangers, Shafting
Chain Belt Co.
Cresson-Morris Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Valley Iron Works

Heaters, Domestic
Alberger Heater Co.
Patterson Kelley Co.
Ross Heater & Mfg. Co.

Heaters, Feed Water
(See Feed Water Heaters)

Heating and Ventilating Systems
Buffalo Forge Co.
Grinnell Company, Inc.
Illinois Engineering Co.
Whitlock Coil Pipe Co.
Warren Webster & Co.

Hoists
Conveyors Corp. of America
Godfrey Conveyor Co.
Washburn & Granger

Hoists, Air
Chicago Pneumatic Tool Co.
Nordberg Mfg. Co.

Hoists, Electric
Beaumont Co., R. H.
Brown Hoisting Mach. Co
Conveyors Corp. of America
Link-Belt Co.
Nordberg Mfg. Co.
Shepard Elec. Crane & Hoist Co.
Washburn & Granger

Hoists, Steam
Nordberg Mfg. Co.
Sullivan Machinery Co.
Washburn & Granger

Hoppers, Coal and Ash
Beaumont Co., R. H.
Brown Hoisting Mchy. Co
Conveyors Corp. of America
Green Engineering Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Hose, Air
Chicago Pneumatic Tool Co.

Hose, Clamps
Chicago Pneumatic Tool Co.

Hose, Rubber
Pioneer Rubber Mills
Quaker City Rubber Co.

Hydrants
Kennedy Valve Mfg. Co.

Ice Machine Repairs
Underwood & Co., H. B.

Ice Making Machinery
Norwalk Iron Wks.
York Mfg. Co.

Ice and Refrigerating Machinery. (See Refrigerating Machinery)

Incinerators
Washburn & Granger, Inc.

Indicators, Flow
Richardson-Phenix Co.

Indicators, Speed
Biddle, James C.
Starrett Co., L. S.

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co.
Crosby Steam Gage & Valve Co.
Robertson & Sons, Jas. L.

Industrial Heat Treating Furnaces
Rockwell Co., W. S.

Injectors
American Injector Co.
Eynon-Evans Corp.
Jenkins Bros.
Lunkenheimer Co.
Penberthy Injector Co.
Powell Co., Wm.
Schutte & Koerting Co.
Sherwood Mfg. Co.

Ladder Treads, Non-Slipping
Irving Iron Works

Lamps, Arc
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Lamps, Incandescent
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Leathers, Hydraulic and Cup
Schieren Co., Chas. A.

Leather Lace
Schieren Co., Chas. A.

Lubricants
Sun Co., The
Texas Co., The
Tide Water Oil Co.
Vacuum Oil Co.

Lubricators, Cylinder
Greene, Tweed & Co.
Keystone Lubricating Co.
Lunkenheimer Co.
Manzel Bros.
Ohio Grease Co.
Powell Co., Wm.
Richardson-Phenix Co.
Sherwood Mfg. Co.

Lubricators, Force Feed
Greene, Tweed & Co.
Ingersoll-Rand Co.
Lunkenheimer Co.
Manzel Bros.
Powell Co., Wm.
Richardson-Phenix Co.

Lubricators, Graphite
Farnsworth Company
Richardson-Phenix Co.

Lubricators, Hydrostatic
Oil Well Supply Co.

Lubricating Oil Filtering, Tanks and Pumps
Richardson-Phenix Co.

Machine Works, Special
Griscom-Russell Co.
Harrisburg Fdry. & Mach. Works
Lammert & Mann
Link-Belt Co.

Metal, Bearing
Ajax Metal Co.
Allan & Son, A.
Magnolia Metal Co.

Meters, Air
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Boiler
Bailey Meter Co.

Meters, Coal
Bailey Meter Co.
C. J. Mfg. Co.

Meters, Feed Water
Bailey Meter Co.
Republic Flow Meter Co.
Webster & Co., Warren
Worthington Pump & Machy. Corp.
Yarnall-Waring Co.

Meters, Flow
Bailey Meter Co.
Republic Flow Meters Co.
Yarnall-Waring Co.

Meters, Gas
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Oil
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.
Richardson-Phenix Co.
Worthington Pump & Mch. Corp.

Meters, Orfice
National Airoil Burner Co.

Meters, Steam
American Dist. Steam Co.
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters V-Notch
Bailey Meter Co.
Hoppes Mfg. Co.
H. S. B. W. Cochrane Corp.
Yarnall-Waring Co.

Meters, Water
American Dist. Steam Co.
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
Republic Flow Meters Co.
Worthington Pump & Mch. Corp.
Yarnall-Waring Co.

Micrometers
Starrett Co., L. S.

Mill, Mining & Railway Supplies
Pitts & Kitts Mfg. & Supply Co.

Motors, Electric
Allis-Chalmers Mfg. Co.
Crocker-Wheeler Co.
General Electric Co.
Ridgway Dynamo & Engine Co.
Westinghouse Elec. & Mfg. Co.

Motors, Water
Roto Co.

Multiwhirl Oil Cooler
Griscom-Russell Co.

Oil & Gasoline Storage Systems
Wayne Oil Tank & Pump Co.

Oil and Grease Cups
Adam Cooks Sons Co.
American Injector Co.
Keystone Lubricating Co.
Lunkenheimer Co.
Ohio Grease Co.
Powell Co., Wm.
Richardson-Phenix Co.

Oil Burners
National Airoil Burner Co.
Schutte & Koerting
Tate-Jones & Co., Inc.

Oil Coolers
Alberger Heater Co.
Griscom-Russell Co.
Schutte & Koerting Co.

Oil Purifiers
Richardson-Phenix Co.

Oil Reservoirs
Burt Mfg. Co.
Coatesville Boiler Wks.
Elliott Co.
Richardson-Phenix Co.

Oil Separators
(See Separators, Oil)

Oil Strainers
Griscom-Russell Co.

Oiling Devices and Systems
Burt Mfg. Co.
Elliott Co.
Lunkenheimer Co.
Manzel Bros.
Nugent & Co., Inc., Wm. W.
Richardson-Phenix Co.
Vogt Machine Co., Henry
Wayne Oil Tank & Pump Co.

Oils, Fuel and Lubricating
Adam Cooks Sons Co.
N. Y.-N. J. Lubricant Co.
The Sun Co.
Texas Company
Tide Water Oil Co.
Vacuum Oil Co.

Packing, Asbestos
Advance Pkg. & Supply Co.
Chesterton Co., A. W.
Crandall Packing Co.
Johns-Manville, Inc.
Sarco Co.

Packing, Cylinder
Rooksby & Co., E. J.

Packing, Flax
Chesterton Co., A. W.

Packing, Hydraulic
Advance Packing & Supply Co.
Chesterton Co., A. W.
Crandall Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Goetze Gasket & Pkg. Co.
Schieren Co., Charles A.
Walker & Co. Ltd., Jas.

Packing, Leather
Schieren Co., Charles A.

Packing, Metallic
American Steam Packing Co
Crandall Packing Co.
Eureka Packing Co.
France Packing Co.
Garlock Packing Co.
Merrill & Co., Wm. B.
Steel Mill Packing Co.
Walker & Co. Ltd., Jas

Packing, Piston
Chesterton Co., A. W.
France Packing Co.
Johns-Manville, Inc.

Packing, Pump Valve
Garlock Packing Co.
Johns-Manville, Inc.

Packing, Rod
American Steam Packing Co.
Chesteron Co., A. W.
Crandall Packing Co.
Eureka Packing Co.
France Packing Co.
Garlock Packing Co.
Goetze Gasket & Pkg. Co.
Greene, Tweed & Co.
Johns-Manville, Inc.
Merrill & Co., Wm. B.
Pioneer Rubber Mills
Quaker City Rubber Co.
Steel Mill Packing Co.
Westinghouse Elec. & Mfg. Co.

Packing Sheet
Advance Pkg. & Supply Co.
Crandall Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Greene, Tweed & Co.
Jenkins Bros.
Johns-Manville, Inc.
Pioneer Rubber Works
Quaker City Rubber Co.
Walker & Co., Ltd., Jas.

Packing, Valve Stem
Crandall Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Greene, Tweed & Co.
Steel Mill Pkg. Co.

Paint, Graphite
Dixon Crucible Co., Jos.

Paint, Metal
Pitts & Kitts Mfg. & Supply Co.

Paint, Smoke Stack
Dixon Crucible Co., Jos.

Pipe
Byers Co., A. M.
Dougherty Co., M. J.
Grinnell Co., Inc.
Kellogg Co., M. W.
Lancaster Iron Works
National Tube Co.
Oil Well Supply Co.
Power Piping Co.
Whitlock Coil Pipe Co.

Pipe Bending
Am. Pipe Bending Mach. Co.
Dougherty Co., M. J.
Grinnell Company, Inc.
Kellogg Co., M. W.
National Pipe Bending Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.
Simmons Pipe Bending Works
Whitlock Coil Pipe Co.

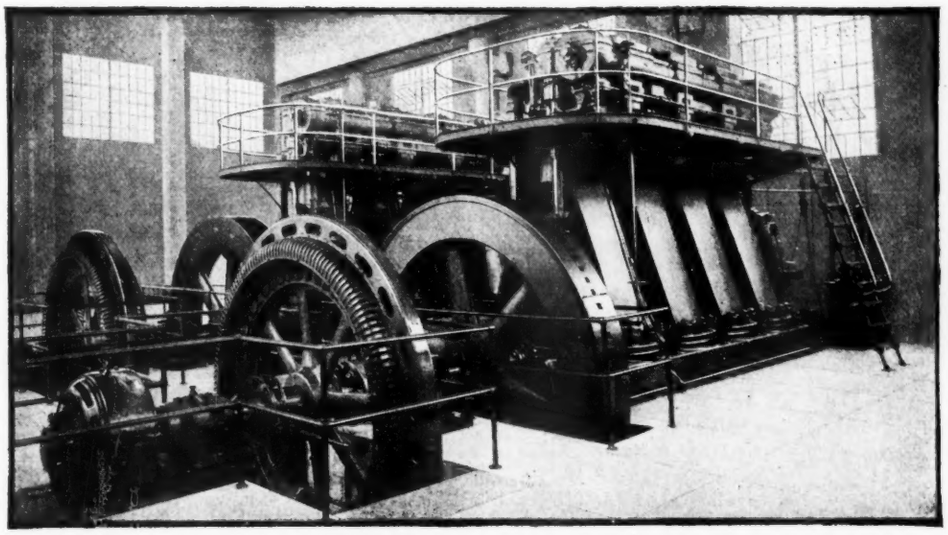
Pipe Coils
Abendroth & Root Mfg. Co.
Superheater Co.
National Pipe Bending Co.
Nat'l Valve & Mfg. Co.
Whitlock Coil Pipe Co.

Pipe Cutting and Threading Machines
Armstrong Mfg. Co.
Curtis & Curtis Co.
Oster Mfg. Co.
Toledo Pipe Threading Mach. Co.
Trimont Mfg. Co.

Pipe Fittings
American Dist. Steam Co.
Dougherty Co., M. J.
Grinnell Company, Inc.
Jefferson Union Co.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equip. Co.
Walworth Mfg. Co.

Pipe Headers, Welded
Dougherty Co., M. J.
Simmons Pipe Bending Works

Pipe Joint Compound
Dixon Crucible Co., Jos.



A Means to Cut Labor Cost in Producing Your Power

The basic reason for buying most machinery is to save labor. That's a fundamental cause for the existence of power plants. Yet labor in the usual power plant still is a big item of expense.

With the Fulton Diesel Oil Engine, all the ordinary labor required to produce power is done by the engine. A Fulton Diesel Engine is a self-contained power plant, and its operation virtually is automatic. The great expense of handling fuel is saved. So far as economical operation is concerned, the human element is removed. All the plant needs is the mechanical attention which any engineer capable of handling a steam plant can give.

The saving in labor is but one point in the efficiency of the Fulton Diesel Engine. From a dollars and cents standpoint, its saving in the cost of fuel is even more important. Then it requires far less space than any other type of power plant of equal capacity, and it maintains its efficiency so that these savings are multiplied by the number of years that the best of steel and iron can last.

Facts To Remember About The Fulton Diesel

A compact self-contained power plant.
For all power purposes in units from 150 to 1,000 horsepower.
In most cases shows clear savings of two-thirds over fuel consumption under boilers.
Thermal efficiency: Steam—15% maximum
Diesel—36% net.
Fuel consumption in direct proportion to load.
Uses cheap fuel.
Constant readiness for operation without stand-by losses.
Quick and easy starting.
Economy independent of size.
Long life with constant efficiency.
Easily operated and maintained by any competent steam engineer.

Our new Bulletin No. 801, illustrating and describing Fulton Diesel Engines and containing other valuable information, will be sent upon request.

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Earle Gear & Machine Co.
Farnsworth Company
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Deming Co.
McGowan Co., John H.
Warren Steam Pump Co.

Pumps, Rotary
Taber Pump Co.
Lea-Courtenay Co.

Pumps, Steam
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Davidson Co., M. T.
Gardner Governor Co.
McGowan Co., The John H.
Oil Well Supply Co.
Pennsylvania Pump & Compressor Co.
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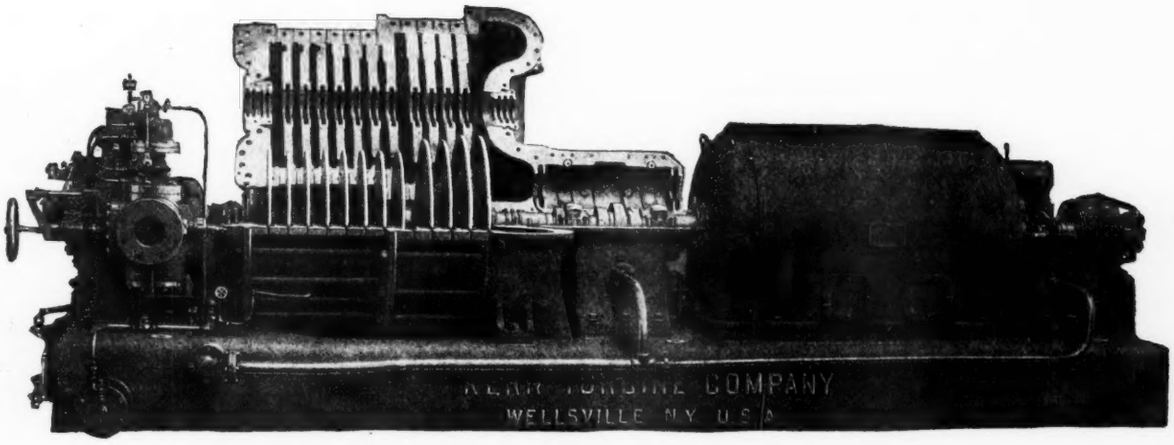

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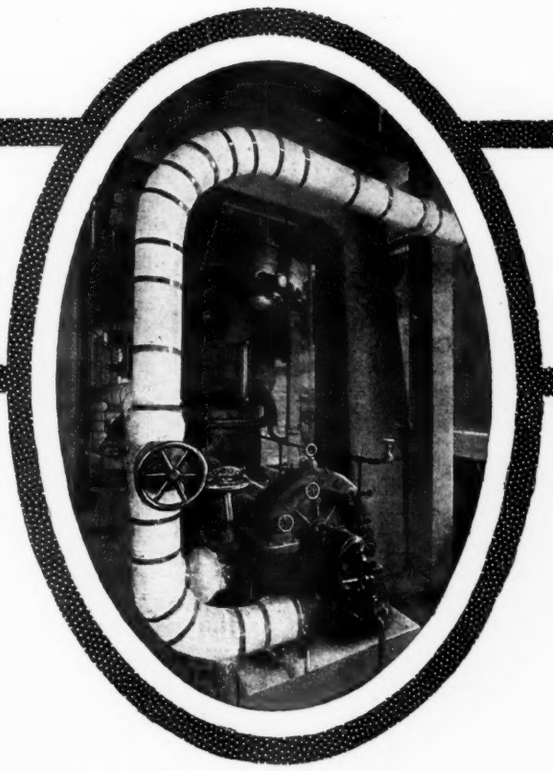

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T-743

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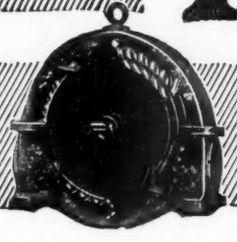

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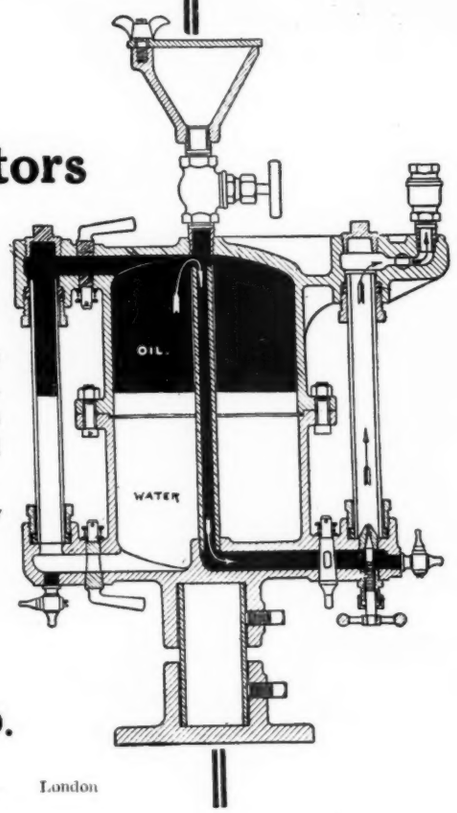

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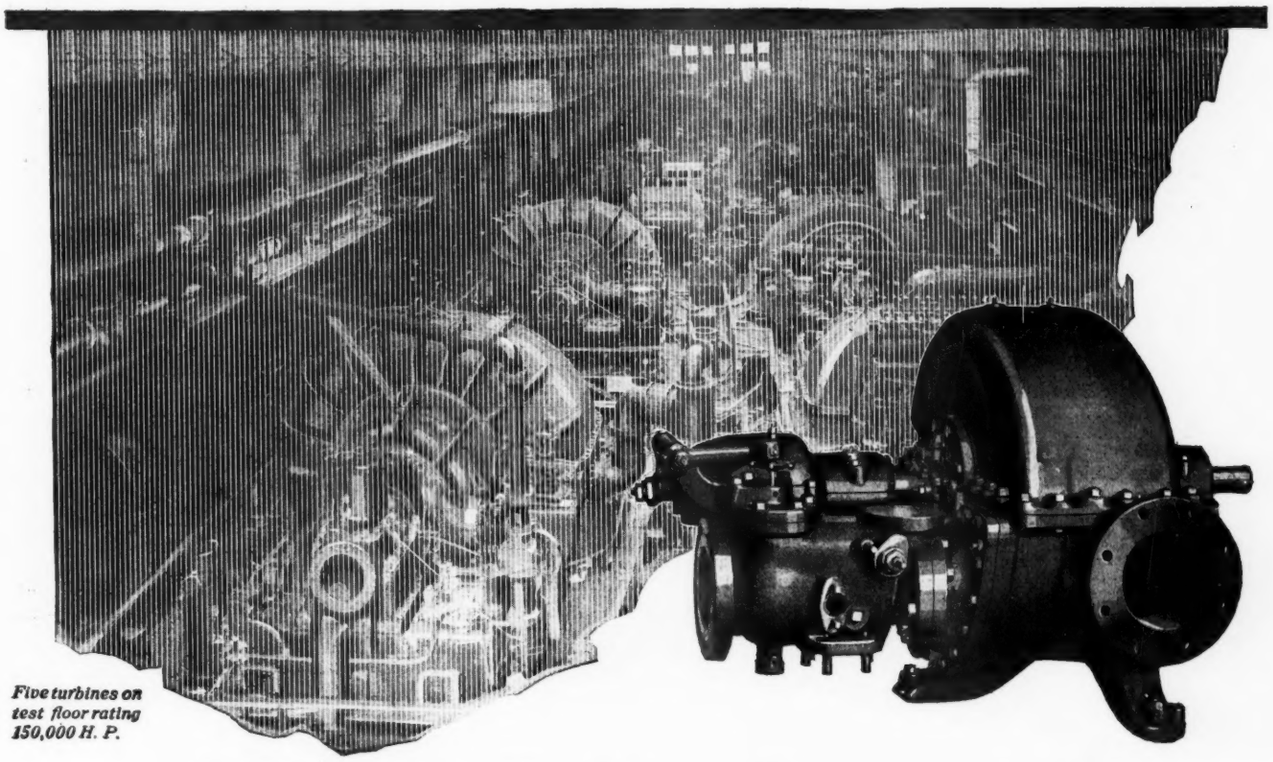

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